

REPORT

ON THE

IMPROVEMENT OF INDIAN AGRICULTURE.

BY

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of the Agricultural Conferences of 1893 and 1895-96.

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PREFACE.

WHAT was intended to be a short Report on the Improvement of Indian Agriculture has, owing to the comprehensiveness and importance of the subject, become expanded into a volume of over 400 pages.

I have not attempted any description of the crops or of the methods of agriculture pursued, but have endeavoured to confine myself to matters in which I believe that improvement can be effected.

While the conclusions I have formed are the result of my own personal observation, I am yet very deeply indebted to others for the information I have collected, and, in particular, to the Government of India and its officials for the exceptional advantages I have enjoyed.

I desire to return publicly my sincere and grateful acknowledgments.

KENSINGTON, LONDON, W.,

March 1893.

J. A. V.

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ABSTRACT OF REPORT.

CHAPTER I.

HISTORICAL INTRODUCTION.

THE opening chapter deals briefly with the history of agricultural Departments in India since their establishment by Minto in 1871.

The failure and abolition of the first Agricultural Department in 1878, and its reconstruction in 1881 as the outcome of the Report of the Famine Commissioners of 1880, are touched upon, and the steps taken by the Government of India in carrying out the recommendations of the Famine Commission are reviewed. It is pointed out that the Government of India, in their Letter of December 1881, clearly recognised the importance of a systematic prosecution of agricultural enquiry which had been so strongly urged by the Famine Commissioners, and that the Government of India, considering that these duties of the Department must precede any attempt at agricultural improvement, first set about the work of "Land Revenue Organisation," and thereby to lay the foundation of all knowledge of the agricultural condition of the country.

The Land Record system, the importance of which was established by the enquiry of the Finance Commissioners of 1880, is then summarised. The reasons, of which the chief was the pressure, why the further recommendations of the Famine Commissioners in regard to agricultural improvement were not carried up are briefly shown, but it is added that the Agricultural Department have not failed to recognise the obligation still resting upon them to take measures for agricultural improvement, as well as the further obligation imposed on them by the Home Department in 1889, to promote agricultural education. It is pointed out that the Agricultural Department, having, by the provisions of the Famine Code, made provision against the difficulties of famine, and having organised the Land Record system, are now prepared to take up the question of agricultural improvement.

In this connection it is stated that the assistance of a first-class Agricultural Chemist has been urged repeatedly since 1880 by the Government of India and by Agricultural Commissions which have met in India, and that finally Her Majesty's Government of Great Britain consented in August 1889 to send out an Agricultural Chemist to make enquiries in India itself, and to advise upon the course to be pursued, as also to report upon the possible improvement of Indian Agriculture. For this duty, I was, on the recommendation of the late Sir James Caird, selected.

The remainder of the chapter is taken up with a summary of my tour, the plan I adopted in pursuing my enquiry, and an expression of my special obligations to those who assisted me in my work.

CHAPTER II

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PRELIMINARY
REMARKS ON
THE POSSIBILITY OF
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IN this chapter I give marks on the condition of its being improved, and point out, however, that the diversities met with in India, alike in its physical features, the people themselves, and their varying surroundings, raise great difficulties which altogether prevent one from speaking generally as to the condition of agriculture. What is true of one part will not be true of another, and almost no question whatever can be answered in the same way for the whole of India. Thus, the problem of improvement becomes especially difficult one.

I explain that I do not share the opinions which have been expressed as to Indian Agriculture being, as a whole, primitive and backward, but I believe that in many parts there is little or nothing that can be improved, whilst where agriculture is manifestly inferior, it is more generally the result of the absence of facilities which exist in the better districts than from inherent bad systems of cultivation. Nevertheless, that improvement is possible is shown, I think, by the differences of agricultural conditions and practice that exist in different parts of India. These differences I proceed to divide into three classes as follows —

- (1) Differences *inherent to the people themselves* as cultivators, for instance, "caste" and "race" distinctions
- (2) Differences *arising from purely external surroundings*, for instance, climate and soil, varying facilities for water, manure, wood, grazing, etc
- (3) Differences *arising directly from want of knowledge*, such as, diversities in agricultural practice

In treating of the above generally, I express my opinion that improvement of agriculture will consist mainly in the modification of the differences which exist, and that this will proceed in two directions, (1) by the transference of a better indigenous method from one part where it is practised, to another where it is not, (2) by the modification of the differences which result from physical causes affecting agriculture. I then discuss how far this work may be effected by the people themselves, as they come to see the necessity of adopting the more profitable methods, and how far by Government, in promoting education, and in taking positive measures such as the provision of water, wood, manure, grazing, etc, where needed. As a necessary preliminary to the taking of positive measures, I support strongly in this chapter the opinion of the Lamine Commissioners and of the Government of India in 1881, that a "systematic prosecution of agricultural enquiry" is absolutely necessary in order to get a real knowledge of

the agricultural needs and condition of each district of the country, and I think that there should be a *permanent agency* for the purpose in each Province, and that in such agency the assistance of an agricultural chemist would be advantageous.

I conclude the chapter by recommending (1) the spread of General and Agricultural Education, (2) the establishment of an organised system of Agricultural Enquiry, (3) the active prosecution and encouragement of positive measures, such as the supply of water, wood, etc., which have already been found to be beneficial.

CHAPTER III.

CULTIVATING CLASSES

It is pointed out that certain "castes" and "races" of the people of India show more agricultural ability than others, and that the differences between them as cultivators are in great measure to be referred to the caste or race distinctions existing between them. It is very certain that if the prejudices attaching to caste and race could be broken down, considerable improvement in agriculture would result. Instances are next given which show indications of a change slowly going on. Thus, the prejudices against the cultivation of indigo and of the potato have, to a great extent, disappeared, also the cases of Nagpur, Poona and Amritsar are mentioned as showing that the prejudice against the use of night soil as manure for crops is giving way. Improvement in coffee cultivation and in the manufacture of indigo, as the outcome of the example of English planters, is also distinctly traceable. The people, it is pointed out, will lose those caste prejudices which retard improvement in agriculture, partly through the spontaneous adoption by them of the more profitable practices, and partly from the force of circumstances which make living harder and oblige more attention to be paid to cultivation. In the weakening of caste prejudice Education is a most important factor, and Government by spreading it will help to break down the caste which prevent progress in agriculture.

I therefore advocate the spread of General Education.

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IN this chapter I give, so far as I am able, some remarks on the condition of Indian Agriculture, the points being improved, and the methods that should be adopted, however, that the diversities met with in India, in its physical features, the people themselves, and their various surroundings, raise great difficulties which altogether prevent one from speaking generally as to the condition of agriculture. What is true of one part will not be true of another, and there is no question whatever can be answered in the same way for the whole of India. Thus, the problem of improvement becomes especially difficult one.

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- (1) by the transference of a better indigenous method where it is practised, to another where it is not,
- (2) by the removal of the differences which result from physical causes. I then discuss how far this work

The principal illustrations by the Report and the

soil are indicated. The neglect, in the past, of any regular scientific study of Indian soils is referred to, and the important question is next dealt with—whether or not the soil of India is becoming exhausted under the present systems of cultivation. It is admitted that there is want of scientific knowledge of the soil, and the Report then discusses the question of exhaustion, from the last

CHAPTER VI

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WATER

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It is indicated, at the outset, that while water in one form or amount and parts of artificial irrigation will be a necessity, in others, again, it may be a useful supplement. The nature of "protected" and "precarious" tracts is pointed out. The main types of water supply are summarised and then examined *in extenso*. Special points are noted, such as the benefits and the evils attending the introduction of canals, the comparison (where it is possible to make it) between cultivation by canal irrigation and by well irrigation, the differences in chemical composition between canal water and well water, etc. Embanking and given of parts which great work done is reviewed, and direct undertaking all works of a major character while minor ones may be carried out by the people. The possibility of Government constructing wells on a large scale is discussed, and improvements are suggested in the management of canal watercourses and tanks, and in the repair of the latter. The chapter goes on to treat fully of the system of advances known as *taccavi*, principally for purposes of well digging, and it is shown how greatly this is capable of further development, and of being made more popular and useful. It is maintained that the Agricultural Department should pay particular attention to this subject, and that a certain share of the administration should be vested in the Department. Suggestions are made as to improvements in the working of the system. Lastly, the necessity of a thorough "agricultural analysis" of each district of the country is insisted on with the view of ascertaining the local requirements in the way of water supply.

RECOMMENDATIONS

I recommend (1) the further extension of canals and other means of irrigation to tracts where they are required, (2) the more energetic working and popularising of the system of *taccavi* advances for well digging and similar purposes, (3) the giving of a share in the administration of *taccavi* advances to Agricultural Departments, (4) the institution by Agricultural Departments of organised enquiry to ascertain the irrigation requirements of each district.

CHAPTER VII

MANURE

THE importance of manure in Indian agricultural systems is illustrated by extracts from various Reports, and the interdependence of water and manure is shown in the existence of the finest cultivation where both water and manure are available. Instances are given to show that the cultivator is not ignorant of the value of manure, but will, for certain crops, spend considerable sums of money upon it. The different sources of manurial supply are then examined, the ordinary cattle-manure being the most important, and, speaking generally, the only one available. Its composition is set out in analytical tables, and a comparison is instituted between it and ordinary farmyard manure, as met with in England, the result being to show that the value of Indian cattle-manure is often underrated, and that when it is burnt (as is so often the case) very serious loss is incurred. As the outcome of an enquiry in which I specially interested myself, I state the conclusion I came to, *viz.*, that the best cultivators do not burn cattle-manure for fuel except from necessity, that is, because they have nothing else to burn as fuel. The connection between the supply of firewood and that of manure is hence a very close one. Other sources of manurial supply are then dealt with in succession, *e.g.*, ashes of cattle-manure, sheep-folding, green-manuring, silt, soil-mixing, oil-seed refuse, nitre, lime, bones, etc., and various analyses of different materials so used are given in the Appendix. Special questions, such as the system of seed-bed cultivation known as *rab*, the use and export of bones, and the likelihood of artificial manures being used in India, are treated in detail. Attention is then drawn to two points in which the cultivator does not take full advantage of the facilities he possesses: (1) the non-utilization by him of night-soil for agricultural purposes, (2) the imperfect conservation of cattle-manure and the loss of the urine. In this connection instances are given of the highly beneficial results that have attended the use of night-soil, and analyses are given showing the value of cattle urine and the advantages to be gained by preserving it by the aid of litter. Incidentally, questions of town and village sanitation are touched upon, and throughout the chapter there are frequent references to investigations which could not be carried on without the aid of agricultural chemistry. In conclusion, it is maintained that water and manure constitute the cultivator's chief wants, and that the supply of manure must go hand in hand with that of water, and must, like the latter, be taken up by Government, otherwise the soil will not be able to provide for the increasing millions of the people. It is further held that, as cattle-manure is the only really available manurial source, it is incumbent on Government to provide supplies of firewood ("Fuel and Fodder Reserves") so that the cattle-manure need not be burnt, but may be set free for use on the land, and the fertility of the latter be thereby kept up.

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annual licenses for the removal of wood, etc., for agricultural uses. These views are supported by the quoted opinions of several authorities, and more especially by a recent Resolution of the Madras Government upon the subject. Cases are also cited where such "reserves" have been created, and have achieved much good. It is maintained that the success of such a scheme must not depend alone upon financial considerations, but should be considered from the point of view of the needs of the people and the demands of the principal industry of the country, *etc.*, agriculture. Extension of the establishment of plantations along canal banks and railway lines is also urged, and the further encouragement of arboriculture. Lastly, the opinion is expressed that a proportion of the yearly revenue obtained by the Forest Department should be expended in the extension of the work of the Department in an agricultural direction.

I recommend (1) the creation of "reserves" of wood, fuel, etc. for agricultural purposes ("Fuel and Fodder Reserves"), (2) the increase of plantations along canal banks and railway lines, (3) the further encouragement of arboriculture, (4) the prosecution of agricultural enquiry for ascertaining the needs of the different cultivating districts in the matter of wood supply, (5) the setting aside yearly of a portion of the revenue derived by the Forest Department, and its employment in the extension of "reserves" to meet agricultural wants.

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CHAPTER IX

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GRASS.

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The different kinds of grazing areas available for the use of the cattle belonging to cultivators are referred to, and attention is drawn to the inclusion of large and valuable grazing areas amid the forests. It is maintained in this chapter that the provision of grazing in forests is a desirable and legitimate object, and one which will much benefit agriculture, whilst in times of drought it may be invaluable in keeping the cattle of the country alive. Nevertheless, it is not regarded as an absolute necessity in ordinary times, and, therefore, should only be carried on under such restrictions as would cause it not to interfere with the other ends which a forest or "reserve" should serve. These various restrictions and the necessity for their imposition are then considered. The question of the utilisation of "village wastes" is next gone into, also the provision of grazing along canal banks and in other plantations. The best way of utilising the grass in forests and "reserves," and the possibility of grass-growing and the supply of pasturage becoming a part of the cultivator's system on his own holding are discussed. In the second part of the chapter the system of Grass Farms and the utilisation of uncultivated grass

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lands (*rukhs*) belonging to Government are explained, and, while their benefit
 are also made
 and silage-making
 mental Farm

the cost in England. The prospects of the development of silage-making in India are treated of and the desirability is urged of making further enquiries at Experimental Farms. Lastly, a change is advocated in the Commissariat Department, whereby the services of men of experience and ability may be retained in the management of Grass Farms, and the formation of a special Forage Branch of the Commissariat is suggested.

RECOMMENDATIONS

I recommend (1) the creation of more "Fuel and Fodder Reserves" to supply grass and grazing; (2) the extension of the system of Grass Farms, and their management by a special Forage Branch of the Commissariat; (3) the carrying out of enquiry at Government Experimental Farms on the making of silage.

CHAPTER X

FODDER CROPS
AND HEDGES

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FODDER CROPS AND HEDGES

The advantages of growing fodder-crops are set forth and exemplified in the better condition of the cattle in many parts where the system is practised. The principal crops used as fodder-crops are mentioned, and, in particular, the utilisation of prickly pear. The scope for extension of the growing of fodder-crops is also shown. It is pointed out that but little is known as to the relative values of different Indian fodders, and that such an

explained, and

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I recommend (1) the extension, wherever practicable, of the systems of growing fodder-crops and of enclosing fields by hedges; (2) the employment of an agricultural chemist in investigating, among other matters, the relative values of different fodders.

CHAPTER XI.

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LIVESTOCK AND DAIRYING.

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It is indicated at the opening of this chapter that, since the differences between the cattle of different districts are largely due to conditions of climate, improvement of cattle is only possible within limits. After speaking of their food and the excellence of

hown that, as a rule, little or
ing and selection. The Hindu
bills is referred to, and the
to follow from a recent legal
decision given in the North-West Provinces as to ownership in

might well be made centres for locating stud bulls for the improve-
ment of the cattle of the district. Accounts are next given of
the Hisar and Bhadgaon Cattle Farms, and mention is made of
the influence which they, and notably the former, have exercised
on the cattle of the country. The evils attending frequent changes
in the superintendence of Government Cattle Farms are pointed
out, as they were in the case of Grass Farms (Chapter IX).
Mention is made of the use of buffaloes as plough cattle, and of
the giving of advances (saccars) for purchase of cattle.

In the second section of the chapter dairying is the main sub-
ject, and the special features of the yield and quality of milk from
cows and buffaloes are treated of. The efforts made to extend dairy
farming in India are detailed in connection with the visit of
Mr. Howman, and the subsequent steps taken by Mr. Ozanne
in Poona and Bombay. The unsatisfactory conditions of the milk
supply to towns and to troops, as well as to Government institu-
tions, are referred to, and the establishment of Dairy Farms is
advocated wherever troops are quartered or large institutions are
situated. It is pointed out that there is considerable work for an
agricultural chemist to do in the investigation of points connected
with dairy farming.

A brief reference is made to the operations of the Horse-
breeding Department, and to attempts made to improve sheep
and goats.

The last part of the chapter is taken up with the consideration
of Cattle Diseases, the ravages which they cause, and the steps
which have been here and there taken to cope with epidemics.
Special mention is made of the establishment of an Imperial
Bacteriological Laboratory at Poona.

I recommend (1) the continuance and extension of Cattle Farms,
and the distribution from them of stud bulls to villages; (2) the
making Experimental Farms and Court of Wards' Estates centres
for the location of stud bulls, (3) the establishment of Dairy

Farms for the supply of milk to troops and Government institutions; (4) an Agricultural Chemist to investigate dairy farming; (5) the prosecution of experiments and the means of preventing epidemics.

CHAPTER XII.

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IMPLEMENTS.

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THE possibility of effecting improvement in the implements of the cultivators is reviewed, and the opinion is expressed that there is but little scope for improvement, and that any advance must be the outcome of a study of native requirements. The success of the Beheera sugar-mill is instanced as a case in point. The question of the use of the native wooden plough, as against that of the iron one, is fully gone into, the several objections to iron ploughs being discussed, and the circumstances under which they might be usefully employed. The chapter then deals with the introduction and use of the following implements:—winnowing-machine, chaff-cutters, and the possible need of more exhaustive trials of implements at Experimental Farms is urged. It is added that in these trials skilled experts, such as engineers, and agriculturists, are required.

RECOMMENDATIONS.

I recommend (1) the exhaustive trial of new implements at Government Experimental Farms; (2) the association of "experts" in such enquiries, (3) the distribution of approved implements from Experimental Farms.

CHAPTER XIII.

CROPS AND CULTIVATION.

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In this chapter no attempt is made to describe the kinds of crops grown, or the methods of cultivation employed, but points only are discussed in which it seems possible to effect improvement. The general excellence of the cultivation is indicated, and the changes, more especially in wheat-growing, which have been brought about by an export trade, are mentioned. Fallowing and rotation are next taken, and instances are given to show that the native cultivator is not ignorant of either practice. The system of "mixed-cropping" is also explained, but it is pointed out that little is known or practised in regard to selection or change of seed, although some Government Experimental Farms have already done good work in growing and distributing pure and selected seed. It is then shown that improvements can be effected by the introduction of new crops, and of new varieties of existing crops, as also in the extended cultivation of certain profitable crops, such as wheat and sugar-cane. It is further demonstrated that by the transference of method from one part to another, improvements in cultivation may be carried out; this is exemplified in the case of sugar-cane, and even in that of a crop so widely cultivated as rice. Reference is made, in conclusion, to the need that exists for getting more knowledge as to the diseases and injuries to which crops are liable, and the best means of preventing them.

I recommend (1) the continuation of experimental enquiry at Government Farms, in reference to new crops and methods of cultivation, (2) the growing of good seed at Government Farms, and its distribution from thence, (3) the study of the diseases and injuries of crops; (4) agricultural enquiry into existing modes of cultivation.

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CHAPTER XIV

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AGRICULTURAL
INDUSTRIES AND
EXPORTS

AGRICULTURAL INDUSTRIES AND EXPORTS.

This chapter deals with certain special crops which undergo a process of manufacture in the country before being sent out of it, or with which particular considerations regarding export are bound up. Such crops are sugar-cane, cotton, indigo, tea, coffee, tobacco, flax, jute, silk, wheat, and linseed. These crops are successively treated in view of the improvements which it is possible to effect either in their cultivation, their manufacture, or in the export trade. It is first shown that the yield of sugar from sugar-cane depends upon points in the cultivation, in the expression of the juice and in its refining, none of which are fully understood. Next, the deterioration of Indian cotton is alluded to, and a brief account is given of the efforts that have been made to improve its quality. Indigo is treated at some length, and the general want of knowledge, both as to its cultivation and the manufacture of the dye, is commented on. Reference is made to the need of chemical investigation into problems affecting the manufacture, and to the unsatisfactory conditions which often attend the cultivation. Similarly, chemical problems in the manufacture of tea are pointed out. The cultivation of coffee is next taken, then that of tobacco, and the native method of curing tobacco is described. After a brief mention of flax and jute, allusion is made to the efforts, so far unsuccessful, to eradicate the disease in silkworms known as *pebrine*. The important matter of the cleaning of wheat is dealt with at length, and by the help of analyses which I made of samples taken off the cultivators' own threshing-floors, or from stores in their houses, it is shown that the fault attributed to Indian wheat, that it is "dirty," does not rest with the cultivator, but is that of the trade, and more particularly the London Corn Trade, who do not want "clean" wheat. The efforts made to improve the trade in this respect, and their failure, are described. The applicability of the "elevator" system to India is also discussed. Lastly, the conditions of the linseed trade are explained, and are illustrated by analyses of a number of samples of seed collected for me in the Central Provinces.

RECOMMENDATIONS

I recommend (1) agricultural enquiry to ascertain the best methods of cultivation and manufacture of crops such as sugar-cane, indigo, tea, coffee, tobacco, etc.; (2) the employment of chemical science in the cultivation and manufacture of crops, more especially the sugar-cane, and in the export of wheat, or to trade in adulterated wheat.

CHAPTER XV

CHAPTER XV

ECONOMICAL AND POLITICAL CONDITIONS

ECONOMICAL
AND POLITICAL
CONDITIONS.

By the insertion of this chapter I wish to recognize the existence of a number of conditions of an economical or political nature which have an important bearing upon the improvement of agriculture, but into the details of which I do not enter. Under this head I mention pressure of population, relative ease or difficulty of living by agriculture, varying systems of land tenure, smallness of holdings, paucity of capital, indebtedness of the cultivating classes, export trade, extension of railways, etc. My reasons for not discussing these several points are given, the only ones mentioned at any length being the smallness of holdings, the indebtedness of cultivators and the lack of enterprise sometimes found among the people, more especially under easy circumstances of living.

CHAPTER XVI

CHAPTER

PRACTICAL ENQUIRY.

PRACTICAL
ENQUIRY

AFTER having sketched out in the previous chapters the principal ways in which I think that improvement of agriculture may be effected, I proceed to consider in those that follow, the agency by which the improvements are to be carried out. A brief review of the recommendations already given points to the conclusion that the main advance will be made by a practical enquiry into native agriculture, with a view to ascertaining (1) the requirements of each district in respect of water, wood, manure, and other facilities, (2) the best native methods of cultivation, in order to transfer them to other districts where they are not practised. A number of opinions in support of this view are quoted, and it is then pointed out that, up to the present, enquiry has been limited to the collection of Land Revenue statistics, and that there has been no organisation for enquiry into agricultural methods with a view to agricultural improvement. A large field for enquiry is then sketched out, and the necessity of an agency of an expert nature is urged. The opinions of the Famine Commissioners, the Government of India and Provincial Governments, on this point are quoted. The existing agency is reviewed, and more particularly the position occupied by the Director of the Department of Land Records and Agriculture in a Province. The lack of technical knowledge in the Department is brought out, and it is suggested that this want could best be supplied by associating with the Director of the Department in any Province a certain number of agricultural experts to be engaged on purely agricultural work. It is then discussed whether these experts should be Europeans or

Natives, and the conclusion is come to that, on the whole, the selection of Natives trained in India would be best, provision being made for the giving of a high class agricultural education in the country itself

ECONOMY
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I recommend (1) the organisation of enquiry into agricultural conditions and practices, (2) the association with the Director of an Agricultural Department of one or more assistants who are experts in agriculture, (3) the selection of these assistants from Natives of India trained in the country itself, (4) the provision of a high class agricultural education in India

CHAPTER
XVII

CHAPTER XVII

SCIENTIFIC
ENQUIRY

SCIENTIFIC ENQUIRY

THE close connection of science with practice in any scheme is at the outset, put forward and radical enquiry should be scientific of chemistry to agriculture is then pointed out, and reference is made to the expressed opinions and renewed applications of the Government of India on the desirability of having an Agricultural Chemist for India. The scope of work for an agricultural chemist is then sketched out, and the principal duties of the office are defined as being the acting as "referee" or adviser to Government in chemico agricultural matters, and the direction and maintenance of the continuity of enquiry. Among other duties are those of assisting in the development of agricultural education and the preparation of suitable text books. The necessary qualifications to be possessed by the holder of such an appointment, and the conditions essential to his successful tenure of it, are defined. The existence of a suitable laboratory, and the co-operation of an assistant chemist (to take actual charge of the laboratory and to give instruction in agricultural chemistry) are regarded as essential. The relations, respective duties and salaries of the two officers proposed are discussed, and it is recommended that neither of them be allowed to undertake private work for separate remuneration. It is urged that not only an agricultural chemist, but also other scientific men such as a botanist, an entomologist, and an agricultural engineer, should be associated with the Agricultural Department for the purpose of conducting enquiry and research. The chapter closes by dealing generally with the position of scientific men in India, and, in particular,

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I recommend (1) as adviser to Government in chemico agricultural matters, and for the direction of experimental enquiry, (2) the appointment of an assistant chemist, (3) the attachment to the Agricultural Department of other scientific officers, such as a botanist, an entomologist, and an agricultural engineer

CHAPTER XVIII.

CHAPTER
XVIII.

EXPERIMENTAL FARMS

EXPERIMENTAL
FARMS

THE causes that have led in India, as well as in other countries, to the establishment of Experimental Farms as separate institutions are first described. The last work of such Farms in India is reviewed, and the expenditure upon them is regarded as not having been excessive, and their continuance is advocated. The chapter then proceeds to deal at length with the work which ought to be done at Experimental Farms, and to lay down the lines for the successful carrying out of experimental enquiry. The various conditions, such as suitability of soil, size of farm, situation, supervision, plan of experiment, recording of results, etc., are discussed, and are illustrated by examples drawn from existing Experimental Farms both in India and in England. It is then maintained that in the case of such Farms the financial test ought not to be the one that determines success. The employment of Experimental Farms as centres for seed distribution, the location of stud bulls, and, at times, for cattle-breeding, is recommended. The establishment of another class of Farms, viz., Demonstration Farms, to show the result of what has experimentally been found useful, is advocated, and mention is made of farms belonging to private individuals where experiment is more or less carried on. The remainder of the chapter is occupied with a review of the work in progress at each of the Experimental Farms which I visited during my tour, my general comments on each Farm being given at the same time.

I recommend (1) the continuance of agricultural enquiry at Experimental Farms; (2) the distribution of seed and the location of stud bulls at Experimental Farms; (3), the establishment of Demonstration Farms.

CHAPTER XIX.

AGRICULTURAL EDUCATION.

CHAPTER
XIX.AGRICULTURAL
EDUCATION

THE influence which general education first, and then, more specially, agricultural education, exert upon the improvement of agriculture is, at the opening, explained. It is then shown that the tendency of education in the past has been too much to a literary, and not sufficiently to an agricultural, direction. The suggestions now given are with the intention of remedying the past defect, and of directing attention to, rather than diverting it from, the cultivation of the land. The intention is, in brief, to give a more agricultural turn to education. The different grades of educational institutions, from Universities and Colleges down to Primary Schools, are then taken in order, and the line of agri-

cultural education at each is briefly sketched out. As regards Universities, it is maintained that they should recognize the importance of agricultural science by making it an optional subject in the final course for a degree in science. It is not considered advisable, at present, to have special Agricultural Colleges, but rather to utilise existing branch of the instruction at Colleges practical and the establishment of Demonstration Farms, and of areas on which the students can themselves work, is advocated. Agricultural Classes in connection with High Schools are well spoken of, and the association with them of Illustration Farms is considered desirable. In Middle Schools it is held that the elements of physical science should be taught, that agriculture should be introduced by means of text books, and that illustration plots rather than farms should be attached to the schools. In Primary Schools a beginning might be made by the introduction of "readers" and of "object lessons" on familiar agricultural topics. Lastly, the importance is inculcated of providing at Normal Schools sound training in agriculture for those who are to become the teachers of others. The paucity of text books on agriculture, and the urgent need for many more of them, are commented on, the relation of the "scientific adviser" to agricultural education is discussed, and it is contended that more inducements to study agriculture should be given, and that the claims of men who have studied it should be freely recognized for appointments in the Revenue and cognate Departments. The chapter concludes with a brief review of the agricultural training given at different Colleges, Agricultural Classes, and other institutions which I visited, including the Forest School at Dehra Dun.

RECOMMENDATIONS

I recommend (1) the spread of general education, (2) the extended introduction of agricultural education into the general educational system, (3) the preparation of agricultural text-books, suitable to the different parts of the country, (4) the recognition of the claims of passed students in agriculture to appointments in the Land Revenue and cognate Departments.

CHAPTER XX

AGRICULTURAL DEPARTMENTS

CHAPTER XX

AGRICULTURAL DEPARTMENTS

THE concluding chapter of the Report deals with some points in the working of Agricultural Departments, which have not already been fully treated. The first is the training of junior Civilians in agriculture. The recommendations of the Famine Commissioners on this subject are discussed, and while it is maintained that it will be impossible to get civilian Directors of Agriculture who will at the same time be practised agriculturists, it is urged that much good may be done by giving at the open competitive and final examinations in England more

weight to proficiency in natural science. It is then suggested that junior Civilians, or at least a proportion of them, should, on arrival in India, be drafted into Provincial Departments of Land Records and Agriculture, there to learn something about the country, the people, the crops, and the agricultural conditions generally, and that at their departmental examinations they should be required to show an acquaintance with these subjects. It is held that Directors of Agriculture should be chosen from the men who have shown a liking for natural science, and who have distinguished themselves subsequently by their knowledge of agricultural matters. The position of the Director of Agriculture is reviewed, and it is urged that it should be invested with some administrative power, and that the Director should form a part of the Revenue Administration. The giving to the Agricultural Department of a share in the administration of Government advances (*faccari*) for well digging is again advocated. The necessity that Directors of Agriculture should tour in their districts is insisted upon, and is made applicable in a special way to the Secretary of the Imperial Department of Agriculture. The useful purposes which occasional Conferences on agricultural questions can serve are also exemplified. The classification of the work of Agricultural Departments is then referred to, and the main heads are briefly noted. Among them the importance of "analysis of districts" and the desirability of making a digest of the Land Records are put forward. Agricultural Shows are treated at some length, and suggestions are made for their improvement, as also for the better conduct of trials of implements.

In conclusion, the future policy of Agricultural Departments is discussed, and the two great needs—a competent organization, and the expenditure of more money upon agricultural improvement—are put prominently forward. Lastly, uniformity of purpose and continuity of policy in the work of Imperial and Provincial Agricultural Departments are strongly urged.

I recommend (1) the giving of more weight to natural science in the open competitive and final examinations for the Civil Service, (2) the drafting of a certain proportion of junior Civilians into the Department of Land Records and Agriculture on their arrival in India, (3) the selection of Agricultural Directors from those who have distinguished themselves in natural science, and subsequently by their agricultural knowledge, (4) the giving of some administrative powers to Agricultural Directors, and, especially, that a share of the administration of Government advances (*faccari*) be entrusted to Agricultural Departments, (5) the granting of more money to be expended by Agricultural Departments in the work of agricultural improvement.

RECOMMENDATIONS



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REPORT ON THE IMPROVEMENT OF INDIAN AGRICULTURE.

CHAPTER I.

HISTORICAL INTRODUCTION.

CHAPTER I.

HISTORICAL
INTRODUCTION.

THE improvement of Indian Agriculture is a subject which in recent years has frequently been brought prominently before the notice of the Government of India and the Home Government. It was in 1866 on the conclusion of the work of the Bengal and Orissa Famine Commission, that the policy of having a special Department to watch over the interests of agriculture was first mooted. Lord Lawrence, however, thought the step premature. In 1870 Lord Mayo again took up the matter, chiefly in relation to the improvement of the supply of cotton from India, and in 1871 the first Agricultural Department was created. In Lord Mayo's opinion the work of the new Department was, "to take cognisance of all matters affecting the practical improvement and development of the agricultural resources of the country." Sir Richard Temple further pointed out that the success of a Central Department depended on the support given to it by similar Provincial Departments, the existence of which, under Local Governments, was implied. The only Provincial Government, however, which rendered any assistance was that of the North-West Provinces, where, in 1875, under Sir John Strachey, then the Lieutenant-Governor, the appointment of a Director of Agriculture and Commerce, to be at the head of a Department for collecting and arranging statistics of trade and agriculture, was sanctioned for a period of five years. Sir John Strachey also advocated the utilisation of Court of Wards' Estates for purposes of investigation, and the employment of them as "Model Farms," and for finding out the real condition of the cultivating classes.

Early history of
Agricultural
Departments

Lord Mayo's
views in 1870.

First
Agricultural
Department,
1871.

Sir John
Strachey and
Provincial
Department of
North West
Provinces 1875

Failure of
Agricultural
Department

The cause.

2 As regards the Central Department, "though" (to quote the words of the Government of India's Resolution of December 1881) "under Lord Mayo's administration a "Department of Revenue, Agriculture, and Commerce was "created . . . the actual firm departed widely from "Lord Mayo's conception of its proper condition. Burdened "with multifarious duties the new Department had neither the "leisure nor the power to take up either directly or efficiently "the many problems which affect the agriculture and rural "economy of the Empire" On its creation the new Department had handed over to it a number of miscellaneous subjects with which the three great divisions of the Administration,

the Financial, Judicial, and Political, did not care to deal So it came about that, with no definite programme of its own, and amid the varied subjects transferred to it, the new Department lost sight of Agricultural Reform. It was not Lord Mayo's intention that this should be so, but it was mainly from lack of provincial co-operation that his efforts were rendered futile, and in 1878 the Department was re-absorbed in the Home Department. The Secretary of State, nevertheless, expressed in a despatch the hope that this step would not interfere with Agricultural Improvement.

Abolition of
Department,
1878

Famine Com-
mission's recom-
mendations
1880

3 In 1880 the Famine Commissioners in their Report gave very strong recommendations as to the necessity of establishing Agricultural Departments under a Director in each Province. The duties were classed under three heads—

- (1) Agricultural Enquiry—the collection of agricultural information to keep the authorities informed of the approach of famine.
- (2) Agricultural Improvement—with a view to the prevention of famine in future.
- (3) Famine Relief—to take charge of operations in the campaign against actual famine.

The Secretary of State himself added to the pressure brought to bear by the Famine Commissioners on the Government of India, and, as the outcome, an Imperial Department of Agriculture was formed in 1881 by again separating the Revenue and Agricultural Department from the Home Department. The several Local Governments agreed to this, and, accordingly, action was taken, and measures were commenced in 1882 for the formation of Provincial Departments of Agriculture.

Imperial
Department of
Agriculture
reconstituted,
1881

Provincial
Departments

Action taken
by Government
of India in
carrying out
recommendations
of Famine
Commission.

Land Record
system.

4 It was, perhaps, on the first of the three heads named above that the Famine Commissioners laid most stress, and the Government of India, in accepting the obligations laid upon them, went still further, and, seeing that no special Department could take (as the Famine Commission had contemplated) the administration of famine relief out of the hands of local officials, turned primarily to the organisation of the Land Record system and the simplification of settlement operations. Improvements were made in the village establishments which had been created under the Land Record system for compiling annually and collating the agricultural facts and statistics of every village in each Province, the Provincial Departments were made Departments of Land Records and Agriculture, and to them the maintenance of the above organisation was entrusted, also on them was put the duty of examining the Land Records and Village Maps, and from these and by means of local enquiry there was to be made an "agricultural analysis," which should indicate, not only the circumstances and conditions of each tract, but also the requirements of each, whether for protection against famine, or for the improvement of the agricultural system.

In the words of the Government of India's Resolution of 1881, "the Famine Commissioners have with great distinctness intimated that, apart from any special organisation which may be required to meet the exigencies of famine, or to enter into any new field of agricultural experiments, a permanent agency should be closely associated with the existing authorities in each Province for the systematic prosecution of agricultural enquiry. The importance of this view, which directs attention to those duties of the Agricultural Department which must precede any attempt at agricultural improvement, has hitherto been far too greatly overlooked." The Resolution further quotes the words of the Famine Commissioners, "the success of an Agricultural Department would mainly depend on the completeness and accuracy with which agricultural and economic facts are collected in each village, and compiled in each subdivision and district throughout the country," and it adds, "the Department would thus naturally acquire that very knowledge which it has hitherto been the main effort of a Settlement staff to attain. Without doubt, too, a permanent Department of this kind would in course of time become more competent to deal with questions of Settlement, demanding, as they do, an intimate acquaintance with agricultural conditions, than any temporary Department forced to gain a hurried experience at great cost to the country during the actual process of assessment." It was distinctly on the understanding that "Land Revenue Organisation" was to form the first duty of the new Imperial Department that Mr (now Sir Edward) Buck accepted office in August 1881 as its Secretary, in the belief that this work, though not so directly agricultural in character, would lay the foundation of all knowledge of the agricultural condition of the country, without which no attempt at "Agricultural Improvement" in the stricter sense could proceed. Meantime a Famine Code was drawn up, and Provincial Departments were gradually established. The work of "Land Revenue Organisation" was then proceeded with, and, when in June 1886 the Secretary of State asked for an enquiry into the expenditure of the new Departments, both Imperial and Provincial, it was found possible to prove satisfactorily to the Finance Commission of 1887 that, on purely financial grounds, and quite apart from any indirect benefit that might have accrued to agriculture, their establishment had been amply justified, and had resulted in the addition of a considerable increase of revenue to the State. Thus the importance of the Land Record system was confirmed, but a time of financial pressure having meanwhile set in, both the Revenue and Agricultural Department and the Finance Department shrank from giving anything like wide effect to the bolder recommendations of the Famine Commissioners which involved expenditure on direct agricultural improvement, although they were pressed by the Secretary of State to "institute measures for Agricultural Research in India" and the promotion of agricultural knowledge in the Civil "Service."

Government of India's Resolution of 1881
18th December 1881

Famine Code

Enquiry of Finance Commission, 1887

Importance of Land Record system established

the Financial, Judicial, and Political), did not care to deal. So it came about that, with no definite programme of its own, and amid the varied subjects transferred to it, the new Department lost sight of Agricultural Reform. It was not Lord Mayo's intention that this should be so, but it was mainly from lack of provincial co-operation that his efforts were rendered futile, and in 1878 the Department was reabsorbed in the Home Department. The Secretary of State, nevertheless, expressed in a despatch the hope that this step would not interfere with Agricultural Improvement.

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Imperial
Department of
Agriculture
reconstituted
1881

The Secretary of State himself added to the pressure brought to bear by the Famine Commissioners on the Government of India, and, as the outcome, an Imperial Department of Agriculture was formed in 1881 by again separating the Revenue and Agricultural Department from the Home Department. The several Local Governments agreed to this, and, accordingly, action was taken, and measures were commenced in 1882 for the formation of Provincial Departments of Agriculture.

Provincial
Departments

Action taken
by Government
of India in
carrying out
recommendations
of Famine
Commission.

Land Record
system.

4. It was, perhaps, on the first of the three heads named above that the Famine Commissioners laid most stress, and the Government of India, in accepting the obligations laid upon them, went still further, and, seeing that no special Department could take (as the Famine Commission had contemplated) the administration of famine relief out of the hands of local officials, turned primarily to the organisation of the Land Record system and the simplification of settlement operations. Improvements were made in the village establishments which had been created under the Land Record system for compiling annually and collating the agricultural facts and statistics of every village in each Province, the Provincial Departments were made Departments of Land Records and Agriculture, and to them the maintenance of the above organisation was entrusted, also on them was put the duty of examining the Land Record and Village Maps, and from these and by means of local enquiry there was to be made an "agricultural analysis," which should indicate, not only the circumstances and conditions of each tract, but also the requirements of each, whether for protection against famine, or for the improvement of the agricultural system.

In the words of the Government of India's Resolution of 1861, "the Famine Commissioners have with great distinctness intimated that, apart from any special organisation which may be required to meet the exigencies of famine, or to enter into any new field of agricultural experiments, a permanent agency should be closely associated with the existing authorities in each Province for the systematic prosecution of agricultural enquiry. The importance of this view, which directs attention to those duties of the Agricultural Department which must precede any attempt at agricultural improvement, has hitherto been far too greatly overlooked." The Resolution further quotes the words of the Famine Commissioners, "the success of an Agricultural Department would mainly depend on the completeness and accuracy with which agricultural and economic facts are collected in each village, and compiled in each subdivision and district throughout the country," and it adds, "the Department would thus naturally acquire that very knowledge which it has hitherto been the main effort of a Settlement staff to attain. Without doubt, too, a permanent Department of this kind would in course of time become more competent to deal with questions of Settlement, demanding as they do, an intimate acquaintance with agricultural conditions, than a temporary Department forced to gain a hurried experience at great cost to the country during the actual process of assessment." It was distinctly on the understanding that "Land Revenue Organisation" was to form the first duty of the new Imperial Department that Mr (now Sir Edward) Buck accepted office in August 1881 as its Secretary, in the belief that this work, though not so directly agricultural in character, would lay the foundation of all knowledge of the agricultural condition of the country, without which no attempt at "Agricultural Improvement" in the stricter sense could proceed. Meantime a Famine Code was drawn up and Provincial Departments were gradually established. The work of "Land Revenue Organisation" was then proceeded with, and, when in June 1886 the Secretary of State asked for an enquiry into the expenditure of the new Departments, both Imperial and Provincial, it was found possible to prove satisfactorily to the Finance Commission of 1887 that, on purely financial grounds and quite apart from any indirect benefit that might have accrued to agriculture, their establishment had been amply justified, and had resulted in the addition of a considerable increase of revenue to the State. Thus the importance of the Land Record system was confirmed, but a time of financial pressure having meanwhile set in, both the Revenue and Agricultural Department and the Finance Department shrink from giving anything like wide effect to the bolder recommendations of the Famine Commissioners which involved expenditure on direct agricultural improvement, although they were pressed by the Secretary of State to "institute measures for Agricultural Research in India" and the promotion of agricultural knowledge in the Civil "Service."

Government of India's Resolution of 1861

Famine Code

Enquiry of Finance Commission 1887

Importance of Land Record system established

the Financial, Judicial, and Political, did not care to deal. So it came about that, with no definite programme of its own, and amid the varied subjects transferred to it, the new Department lost sight of Agricultural Reform. It was not Lord Mayo's intention that this should be so, but it was mainly from lack of provincial co-operation that his efforts were rendered futile, and in 1878 the Department was re-absorbed in the Home Department. The Secretary of State, nevertheless, expressed in a despatch the hope that this step would not interfere with Agricultural Improvement.

Abolition of
Department,
1878

Famine Com-
mission & recom-
mendations
1880

3. In 1880 the Famine Commissioners in their Report gave very strong recommendations as to the necessity of establishing Agricultural Departments under a Director in each Province. The duties were classed under three heads—

- (1) Agricultural Enquiry—the collection of agricultural information to keep the authorities informed of the approach of famine.
- (2) Agricultural Improvement—with a view to the prevention of famine in future
- (3) Famine Relief—to take charge of operations in the campaign against actual famine

Imperial
Department of
Agriculture
reconstituted
1881

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Government of India Resolution of 1881
 1881

Famine Code

Enquiry of Finance Commission 1887

Importance of Land Record system established

Application for
Agricultural
Chemist.

5. On one point, however, distinct representations had gone home to the Secretary of State, *viz.*, the necessity of having a scientific ground-work as the basis of all attempts at agricultural improvement, and Chemistry being that science which bears, perhaps, most directly on Agriculture, the Secretary of State was asked as far back as 1882 to sanction the appointment of an Agricultural Chemist to act with the Department. It was pointed out, among other things, that there were large tracts of land, especially in the North-West Provinces, which were unculturable on account of the presence of noxious salts, and it was thought that science might aid in reclaiming these lands. There was also a further intimation that a Chemist for educational purposes was urged, *viz.*, in 1882, to come of the Delhi Conference of that year.

Imperial Department of Agriculture ready in 1903 to take up recommendations of Famine Commissioners and Agricultural Improvement

6 In 1888 the Imperial Department having, in accordance with the Famine Commissioners' scheme (emphasised, as it was, by the Secretary of State), established Provincial Departments of Agriculture, having made provisions, by means of the Famine Code, against the difficulties of famine, and having, lastly, by the Land Record system, provided machinery for manufacturing agricultural statistics for the administration of Land Revenue and the collection of agricultural information, they announced their work to be in a sufficiently advanced state to enable them to take up the remaining section of the Famine Commissioners' recommendations, *viz.*, that referring to agricultural improvement. In connection with this the appointment of an Agricultural Chemist was once more urged. It was pointed out most clearly by the Government of India that the obligation imposed on them by the Secretary of State to give effect to the recommendations of the Famine Commissioners in relation to agricultural improvement still rested upon them, and that so long as they were not relieved from this obligation it remained in full force, further, that the other recommendations having been provided for and financial pressure having become less severe, they were now prepared to turn their attention to agricultural improvement. Still later (1889), the Home Department, by their Resolution on Technical Education, directed the Educational Departments to take measures for the education of agriculture. Consequently the Agricultural Departments, Imperial and Provincial, have at the present time before them the positive duty of promoting both Agricultural Improvement and Agricultural Education.

Resolution of Home Department on Technical Education 1889 obligation on Agricultural Departments to promote Agricultural Improvement and Agricultural Education

Further application for Agricultural Chemist July 1889

7. The Delhi Conference, before-mentioned, had strongly represented the necessity of having at least one first-class Agricultural Chemist for India, and had urged that the employment of such a man in connection with the expansion of the Forest School at Dehra, and with the College of Science at Poona, would be desirable for educational purposes, his time, when not engaged in the actual work of teaching, being devoted to agricultural enquiry. These views were endorsed in a despatch to the Secretary of State, dated July

21st, 1858. In reply, the Secretary of State, after seeking the opinions of the late Sir James Caird and Mr. Threlton Dyer (opinions, it may be said, in several respects divergent, but agreeing as to the undesirability of making teaching a main point in the duties of such a man as might be chosen), expressed himself still unable to agree to the recommendation urged on him, and asked for further explanation. Thus the Government of India gave in their reply of June 1st, 1859, pointing out in detail the various classes of Natives for whom education in agriculture was desirable, and reiterating the necessity for systematic scientific enquiry in agriculture.

Reply of
Peers & of
House to
application.

8 The Secretary of State, though not prepared without further investigation to accept these proposals, expressed his willingness to send out a competent Agricultural Chemist who should make enquiries in India itself, and (in the words of the despatch of November 7th, 1859) "advise upon the best course to be adopted in order to apply the teachings of "Agricultural Chemistry to, and in order to effect improvements in, Indian agriculture." The selection of an expert was entrusted to Sir James Caird, who himself had been one of the Famine Commissioners.

Sanction given
to enquiry by
expert, August
1859

Sir James Caird did me the great honour of mentioning my name first, and in preferring on behalf of the India Council the request to the Royal Agricultural Society of England for the use of my services, he expressed the hope that the Society (of which he was himself one of the oldest members) would, in view of the importance and national character of the work, see their way to allowing me to undertake it, and to grant me the necessary leave of absence from my post as their Consulting Chemist.

Selection of
myself by Sir
James Caird

The Society, on their part, heartily granted the request made by Sir James Caird, and my delegation to India was ratified by the India Council.

Leave of absence
granted by Royal
Agricultural
Society of
England

Accordingly, on November 21st, 1859, I left London en route for Bombay, and arrived in India on December 10th

Arrival in India
December 10th,
1859
F. spouse of my
mission

9 The purposes of my deputation were thus defined by the Secretary of State :

To enquire into and advise upon—

1st.—The improvement of Indian Agriculture by scientific means

2nd.—The improvement of Indian Agriculture generally.

The method of enquiry I followed was, first to acquaint myself as far as I could, by travel, with the agricultural conditions of the country, as exemplified in selected tracts of a typical character, to visit all Experimental Stations and also the principal experiments conducted in the past by Government or by private individuals, to inspect educational institutions where agricultural teaching formed a part of the curriculum ; and to obtain, by free discussion with officials and practical agriculturists, whatever information and suggestions I could as to the agricultural needs of the country. Taking one district specially, the Cawnpore district of

My method of
enquiry

the North-West Provinces, I visited it repeatedly, so as to follow systematically in one locality the progress of the various field crops at the different stages of their growth. Besides seeing the general agricultural crops, I enquired into the more special industries connected with coffee, tea, indigo, and jute growing, and into systems of Irrigation, of Grass Farms, and of Forest Administration.

317 10079

10. My travels were mainly divided into two tours—the first from December 10th, 1889, when I arrived, until May 19th, 1890, when I reached Simla, my main object being to see the cultivation during the cold weather; the second, from July 14th until September 12th, which was occupied in seeing the agriculture of the country during the rainy season. In the interval spent at Simla between the tours, I had the opportunity of putting together the notes of my first tour, of consulting all officials connected with the Agricultural Department, and others interested in agriculture, and I also had free access to the records and library of the Department. I further drew up a brief summary of the conclusions I had arrived at up to that time, and these, under the name of "Preliminary Notes," were circulated privately, and were subsequently discussed. These were held in October 1890 at Simla. The conclusion of my second tour, I procured fresh information

Agricultural
conference at
Simla, October
1890

and the arrangement of the material I had already gathered for the purposes of my Report. The assembling of the Agricultural Conference at Simla, October 6th to 18th, after Sir Edward Buxton's return from Ludlow, gave me the opportunity, of which I was glad to avail myself, of submitting my views in the consideration of the members composing the Conference, and of hearing their opinions and noting their suggestions. Leaving Simla in November, I made a short third tour before reaching Calcutta, and finally left India on January 10th, 1891, having been just thirteen months in the country. Thus, omitting Burma and Assam, which were not included within the scope of my enquiries, I was able altogether to visit each of the different Provinces twice, with the exception of the Punjab, viz., once in the cold weather and once in the rains. In the case of the Punjab the season had advanced too far to enable me to see the cold-weather crops, except just in the neighbourhood of Delhi.

Expressed in
general
conclusions

11. The duty now devolves upon me of putting together my conclusions and suggestions, based upon what I was able, in the time at my disposal, to see of the agriculture of the country, what I have gathered from the literature of the subject, and, above all, what I have gained from the experience of the many officials and others it has been my privilege to meet, and who have been always ready to assist me in every way possible. In the account of my tours I shall duly acknowledge the help that individuals have so kindly rendered me, but I must not pass on without mentioning some special obligations I owe.

Among the first I must name the late Sir James Caird, to whom I was indebted for my selection, and who gave me much advice derived from his own experience in India, and his acquaintance

ance with its officials since, then Sir James Peile, of the India Council, and Sir Charles Bernard, of the India Office. Sir James Peile had charge in the Council of the matter of my delegation, and Sir Charles Bernard made the arrangements for my visit, and assisted me much by advice and suggestions, as also, after my return, in the issuing of my Report.

On the voyage out it was my good fortune to meet Mr. Robert H. Elliot, of Clifton Park, Kelso, well known both as a Scotch agriculturist and as a coffee planter in Mysore, and besides as an able writer on Indian agricultural matters. From him I learnt much that was afterwards invaluable to me.

In India, I must specially name Sir Edward Buck, Secretary the Revenue and Agricultural Department of the Government of India, who took a deep personal interest in my mission, and provided for me every facility for making my investigation a complete and independent one. Sir Edward himself arranged for me an extended tour, and commended me everywhere to the officials of his Department. I was able to see every . . . no opportunity of meeting . . . the Agricultural Department in the past, as well as with its objects and aims in the future, Sir Edward himself took me on my first tour to the North-West Provinces, and then on to Berar, Indore, and Bombay.

Next, I would express my indebtedness to the several gentlemen, mostly Directors of Provincial Departments of Land Records and Agriculture, who arranged tours for me in their respective Provinces, and who themselves personally conducted me throughout, providing in every way for my comfort, and ensuring that in the time at my disposal I should see, not only as much as possible, but also what it would be most advantageous to see. To them my sincere obligations are due, and I have over-fresh recollections of much pleasant acquaintance with them, and of kindnesses received from them. These are —

- * Mr. J. B. Fuller (Central Provinces)
- * Mr. E. C. Ozanne (Bombay)
- * Mr. T. W. Holderness (North-West Provinces and Oudh)
- * Mr. M. F. Maclean (Bengal)
- * Mr. F. A. Robertson (Punjab)
- Mr. C. Benson (Assistant Director, Department of Agriculture, Madras)
- Mr. Mohammad Husain (Assistant Director, Department of Agriculture, North-West Provinces and Oudh)
- Mr. H. C. Hill (Officiating Inspector General of Forests)
- Mr. W. B. Wishart (Secretary, Upper India Chamber of Commerce, Calcutta)

* Directors of Provincial Departments of Land Records and Agriculture.

I have further to express my thanks to His Excellency the Viceroy (Marquis of Lansdowne) for much personal kindness.

shown to me, and interest taken in my mission, as evinced in the several interviews graciously accorded me, to Their Excellencies Lords Reay, Harris, and Connemara, whose guest I have been at different times, and to the following Members of Council and Governors of Provinces for kind suggestions and advice Sir Archibald Colvin, Sir James Lyall, Sir Stuart Bayley, Sir David Harbour, Sir G. O. Chesney, Sir Charles Elliott, Hon Mr (now Sir Philip) Hutchins, Messrs Stokes (now Sir Henry Stokes), Garstin, and Clogston, of Madras, and Mr. A. (now Sir Alexander) Mackenzie.

There are many other officials to whom my thanks are similarly due for much assistance rendered me in my enquiries, notably Colonel Forbes, Mr. Harvey James, General Badoock, Mr. W. C. Bennett, Mr. P. Nolan, Mr. Justice Jardine, Mr. H. E. M. James, Colonel Ardagh, Mr. I. Henvey, Dr Geo King, Dr Geo. Watt, Mr J. E. O'Connor, Mr Duthie, Colonel Pitcher, Colonel Marriott, Colonel F. Bailey, Major Chibhorn, Mr. W. J. Wilson, Dr. Theodore Cooke, Major Elliott, Major Wingate, and the late Mr S. A. Hill.

Among the most pleasurable recollections of my tours will be those associated with the visits I paid to agriculturists, planters, and others to whom I was commended, and who everywhere showed me the greatest hospitality. It is impossible here to record the names of all, though they are well remembered by myself, but I must mention as representative,—Mr. R. H. Elliot of Mysore, Messrs W. B. Hudson, J. J. Macleod, and T. M. Gibbon of Behar, Captain Chapman (Oudh), Captain Goad (Hapur), Messrs Thomson and Mylne (Beheea), Mr Macdonell (Serajpunge), Mr G. W. Christison (Daryeling), Dr Hendley (Jeypore), and, in the Punjab, Messrs E. B. Francis, E. B. Steedman, J. A. Grant, H. C. Cookson, Captain Marrett, Major Massey, and Dr. Warburton.

Both at Calcutta and at Bombay I obtained from merchants much information which materially aided me in forming my conclusions. I would acknowledge here the kind help of Messrs Octavius Steel & Co, Mackillochan & Co, and Mr Ross (Kelly & Co) at Calcutta, and of the following firms at Bombay: Messrs Volkart Brothers, Finlay, Muir & Co, Glade & Co, Croft, Wells & Co, and Mr. John Marshall, of the Chamber of Commerce.

Lastly, I have pleasure in acknowledging the ready way in which the facilities of the office of the Revenue and Agricultural Department have been put at my disposal by Mr. Muir-Mackenzie, Mr Tucker, and the other officials, also the great assistance I have derived from having had access to the records and library. To this Department I am further indebted for the preparation, by the Survey Office, of the three maps which accompany my Report, the Rainfall and Geological maps having been specially reduced from those in the "Statistical Atlas of India."

12. In one respect I have had an advantage over those whom I may term my "predecessors," in that a full year and exceptional opportunities have been given me. I believe, too, that short though the time at my disposal has been for the study of so large a subject as Indian Agriculture, my enquiry from a scientific point of view will have beneficial results.

It was my desire to avail myself, while still in the country, of the opportunity of gathering whatever information I could in order to supplement and to test my own observations; and so numerous were the matters brought under my notice during my travels, that, even with the extension of time granted me by the Government of India, and acceded to by the Royal Agricultural Society, I was unable to do justice to this large and important question of Agricultural Improvement. Rather than that I should be prevented from dealing adequately with it, I was very kindly allowed to present, on leaving India in January 1891, an Abstract Report and to write the full Report subsequently, at my leisure.

CHAPTER II.

CHAPTER II.

PRELIMINARY
REMARKS
ON THE
POSSIBILITY OF
IMPROVING
INDIAN
AGRICULTURE

Passage of mak-
ing general
remarks on
Indian
agriculture

Complexity of
the sub-obj

PRELIMINARY REMARKS ON THE POSSIBILITY OF IMPROVING INDIAN AGRICULTURE

13 It has been well said, and cannot be too often repeated, that "India is a country about which one cannot make a 'general' remark," and, certainly, with regard to Indian agriculture, this is strictly true, therefore, if I am asked whether the agriculture of India is capable of improvement, I must answer both "Yes" and "No." If, for instance, I am taken to see the cultivation of parts of Gujarát (Bombay), of Máhim in the Thána District of Bombay, the garden culture of Coimbatore in Madras, or that of Meerut in the North West Provinces and of Gújrat and Hoshiarpur in the Punjab, I may be inclined to say, "No, there is nothing," or, at all events, very little, that can be bettered here," but if, instead, I visit parts of Behar, the Dacca district of Eastern Bengal, the Central Provinces generally, Khándesh in Bombay, the Tanjore district of Madras, the Cawnpore district of the North-West, or Hissar and Multan in the Punjab, it will not be long before I may be able to indicate a field for improvement. Therefore, no general reply can be properly made to the question suggested, nevertheless, I do not hesitate to say that very frequently there is room for improvement, but it will have to be *looked for*, as a rule. Then, with the finding comes a yet harder problem, namely, to ascertain how improvement can be effected. If the deficiencies do not fall readily to hand, still less do the remedies, and I make bold to say that it is a much easier task to propose improvements in English agriculture than to make really valuable suggestions for that of India such suggestions, I mean, as have a reasonable chance of being carried out. Altogether, the condition of the cultivating classes, the peculiar circumstances under which husbandry is carried on, the relations of the State to the people, and many other factors, have to be taken into careful consideration before one can give an opinion, and even that opinion must be given in very guarded terms. As India is not covered by *one* people, but by a number of different and diverse peoples, so may it be said of the agriculture and its systems as practised in different parts. That it not only needs, but will repay, close and careful study, I am convinced, and until systematic enquiry be made, not in the hurried way in which the exigencies of the case have obliged me to pursue my enquiries but by patient watching and learning, no really sound knowledge will be obtained, nor any great improvement be intelligently inaugurated.

14. On one point there can be no question, viz., that ideas generally entertained in England, and often given to even in India, that Indian agriculture is, as a

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entirely in
served to India
retention

whole, primitive and backward, and that little has been done to try and remedy it, are altogether erroneous. It is true, as indicated above, that on matter what statement may be made, as deduced from the agriculture of one part, it may be directly contradicted by a reference to the practice of another part, yet the conviction has forced itself upon me that, taking everything together, and more especially considering the conditions under which Indian crops are grown, they are wonderfully good. At his best the Indian *rayat* or cultivator is quite as good as, and, in some respects, the superior of, the average British farmer, whilst at his worst it can only be said that this state is brought about largely by an absence of facilities for improvement which is probably unequalled in any other country, and that the *rayat* will struggle on patiently and uncomplainingly in the face of difficulties in a way that no one else would.

Nor need our British farmers be surprised at what I say, for it must be remembered that the natives of India were cultivators of wheat centuries before we in England were. It is not likely, therefore, that their *practices* should be capable of much improvement. What does, however, prevent them from growing larger crops is the limited facilities to which they have access, such as the supply of water and manures. But, to take the ordinary acts of husbandry, nowhere would one find better instances of keeping land scrupulously clean from weeds, of ingenuity in device of water-raising appliances, of knowledge of soils and their capabilities, as well as of the exact time to sow and to reap, as one would in Indian agriculture, and this not at its best alone, but at its ordinary level. It is wonderful, too, how much is known of rotation, the system of "mixed crops," and of fallowing. Certain it is that I, at least, have never seen a more perfect picture of careful cultivation, combined with hard labour, perseverance, and fertility of resource, than I have seen at many of the halting places in my tour. Such are the gardens of Māhim, the fields of Nadiad (the centre of the "garden" of Gujarāt, in Bombay), and many others.

But to return to the question of improvement; while some have erred by calling the agriculture primitive, and, forgetting that novelty is not necessarily improvement, have thought that all that was needed was a better plough, a reaper, a threshing machine, or else artificial manures, to make the land yield as English soil does, others have equally erred by going to the opposite extreme, and have condemned all attempts at improvement, asserting that the *rayat* knows his own husbandry best, and that there is nothing to teach him. On one point, however, there can be but little doubt. The Native, though he may be slow in taking up an improvement, will not hesitate to adopt it if he is convinced that it constitutes a better plan, and one to his advantage.

15. Turning from these various opinions to those of the Famine Commission, it will be apparent that, as one result of their careful investigation, they came to the conclusion that there undoubtedly was capability of improvement, or they would not

have so strongly insisted on measures being taken to effect it, they recognised, too, the necessity of careful and organised enquiry as a preliminary measure, and as necessary for acquiring a real knowledge of the agricultural state and conditions of the country. "The defect," says the Report (Part II, p. 133), "in the efforts made by the Government to instruct the cultivator has consisted in the failure to recognise the fact that in order to improve Indian agriculture, it is necessary to be thoroughly acquainted with it, and to learn what adaptation is needed to suit modern and more scientific methods and maxims to the Indian staples and climate." Here, however, came in the difficulty of effecting any remedy, and the section of the Commission's Report which deals with remedial action, though it indicates certain possible improvements, does not give any direct suggestion as to how they are to be carried out. The Government of India, as I have pointed out when called on to give effect to the Famine Commissioners' recommendations, felt this same difficulty, and, having neither the machinery nor the means put the matter aside until they could work out other reforms called for by the Famine Commission's Report. They have, however, never questioned the possibility of improvement in agriculture, and their action at the present time indicates this opinion strongly, what they have done is, to ask for the necessary machinery and the necessary money, and they have, as I think, wisely, determined that the work, if undertaken, shall be begun in a thoroughly scientific manner, and founded on a thoroughly scientific basis.

Opinion of
Government of
India.

16. I will not discuss here the opinions of the several "experts" who have preceded myself, leaving on record, as they have done, the conclusions drawn from the observations of their several tours. But I will give my own views, though well aware that I am adding one more to the list of opinions based on a more or less casual acquaintance with the agriculture, not of a country, but of a continent. The attitude one ought to adopt in coming to a land full of novel conditions is that of a learner, and not of the adviser or the critic, it is only when one has learnt something of the peculiar surroundings of his subject that he should attempt to suggest anything, and this he will, if wise, do very cautiously, feeling how very much there is for him still to learn, how much that he will never be able to learn. This is pre-eminently the case with Indian agriculture.

Attitude of the
enquirer

My opinions in
this paper are
based on a study of
actual and
imagined.

It is necessary to
have a clear
view of the
actual and
imagined
state of
the country.

17. My own investigations have brought very clearly to my notice what I have already alluded to in paragraph 13, viz., that there are very great differences in the agricultural conditions and practice that prevail in different parts of India, so that while in some parts, as, e.g., in Gujarât (Bombay), the agriculture is so good as to leave little room for improvement, in other parts, as, e.g., in the Central Provinces, there is much scope for it.

My investigations have also shown me that there are great differences in the facilities that some cultivators have, as compared with others, facilities, I mean, such as those for obtaining water, manure, wool, grazing, etc.

The first aim in any scheme of agricultural improvement should, I think, be to modify those differences which exist; first of all, by teaching, in the more backward parts of India, the better practices of the most advanced Indian agriculture; and, secondly, by supplying, wherever it is possible, those facilities which exist in the best agricultural districts. It is in the existence of these differences that there is a warrant for belief in the possibility of improving Indian agriculture, and it is in the modification of them that the greatest hope of improvement lies. Apart, therefore, from the question whether the agriculture of the country can be improved by the introduction of more scientific methods from the West, I believe the first step must proceed in the direction of improvement from within, in other words, by the modification of those differences in agricultural conditions and practice that exist in different parts of India itself.

These existences
the ground for
possible
improvement in
Agriculture

I shall now proceed to enumerate these differences, and shall then show how, in my opinion, they may be most easily modified.

18. The differences appear to me to range themselves into three separate classes; and, after naming these, I shall proceed to briefly indicate, in a general way, the direction which modification of differences, where possible, may be looked for. In subsequent chapters I shall deal with each sub-division separately.

Three classes of
differences

The three classes are —

I. Differences *inherent to the people themselves* as cultivating classes—

I Differences
inherent to the
people them-
selves

for instance, the fact that, by hereditary practice, certain castes and races are bad, others are good cultivators

II Differences *arising from purely external surroundings*, and not directly from any want of knowledge. These may be subdivided into—

II Differences
arising from
purely external
surroundings—

(a) physical causes—

(a) physical
causes

such are —climate, soil, facilities for water, manure, wood, grazing, etc.,

(b) economical or political conditions—

(b) economical
or political
conditions

such are —the relative ease or difficulty of living, paucity or pressure of population, etc

III. Differences *arising directly from want of knowledge*—

III Differences
arising directly
from want of
knowledge

for instance, the existence of diversity of agricultural practice in different parts of the country

19. Having stated the differences, it is desirable to consider in the next place the means by which they may be removed, or at least be modified.

Assesses by
which improve-
ment is to be
affected

This I can best put in the form of three propositions —

1st The modification of existing differences in agricultural practice and methods must proceed from positive measures taken—

(a) by the people themselves ;

(b) by the Government.

2nd So far as it is possible for Government or for Agricultural Departments to assist in the modifications of these differences, it is their duty to do so

3rd It is the work of Government to test Western practice and the applications of modern science, as also to introduce them when found suitable for India.

20 It will be well now to illustrate the foregoing differences, and, in indicating how their modification may be carried out, to give, at the same time, a sketch of the method I intend to adopt in the succeeding chapters of this Report

1. Differences inherent to the People themselves

It is well known that certain castes and races have been prevented by religious prejudices or "historical causes" (to use Sir Charles Elliott's expression) from adopting the more skilful or more laborious systems of cultivation in vogue among other castes or races. Thus, the Rajputs, Brahmans, Kolis, and Kols may be mentioned as hereditarily inferior as cultivators to the Jats, Kurmis, Lodhas, Kachhis, and others. Here it is not so much that the external surroundings are unequal, nor that the agricultural knowledge is at fault, but the real cause is found in the inherent differences of the people themselves. Side by side, in the same village, one may, for instance, see both superior and inferior husbandry, the explanation being found primarily in a reference to the respective caste of the cultivator in each case. In Behar I once saw a quantity of dung lying about in heaps on a field not spread out, but, between the rain and the sun, speedily losing its goodness. It had been lying about so for a considerable time. On asking a neighbouring cultivator why the owner did this, the reply was, 'He is only a gatherd,' meaning thereby that he did not belong to a good cultivating class. Here the people of this caste evidently required to be taught better methods of agriculture, and how to manage properly the manure at their disposal. The modification of such differences (to revert to my propositions in paragraph 10, will, in some cases, be effected by the people themselves in the gradual abandonment of their prejudices

Illustrations of differences

I. D. Strangers
inherent to the
people them-
selves

This must be done by the
people themselves

and the adoption by them of more profitable practices. A change of this kind has been seen in the adoption of indigo cultivation by castes who formerly used to consider indigo an unclean thing. Another instance is the extension of cultivation of the potato, against which a religious prejudice existed on the ground that it was "flesh." The work that Government can do, and the duty that should be its, is to assist in raising the level of the people through the spread of Education. This will continue to do, as it has already done, a great deal to break down prejudice. Further than this the Government can do little, if anything.

Their modification by the Government through Education

II. Differences arising from purely External Surroundings.

(a) *Physical Causes*—These may be subdivided into—

If Differences arising from external surroundings—

(a) physical causes

(i) climate and soil,

(ii) facilities for water, manure, wood, grazing, etc

(i) These two—climate and soil—stand in a different category to the others. They are fixed by geographical and geological considerations, over them neither the people nor Government have more than a limited control, and consequently comparatively little can be done to modify the differences. For instance, it is not possible to compare agriculture under the influence of a damp climate and abundant rainfall, such as prevails in the greater part of Beogal, or below the Western Ghats of Bombay, with that of the dry parched plains of Multan and elsewhere in the Punjab. Equally impossible is it to find a resemblance between the rich black cotton soil of Berar or the Central Provinces, and the sandy soils of Sirea, or other parts of the Punjab. The planting of trees may indirectly modify the rainfall, and plentiful manuring may improve the poorer soil, but they will be powerless to make the one locality or soil really like the other.

(i) climate and soil
Modification of these differences only possible within limits

(ii) Here we have a set of physical causes giving rise to differences which, unlike those in the case of climate and soil, it is in the power, both of individuals and of Government, to mitigate to a considerable extent.

(ii) facilities for water manure wood grazing etc

Marked indeed are the differences between parts plentifully supplied by wells, or through which streams or canals flow, and those, where these features are absent, so, again, the differences are great between treeless tracts and those in which

forests abound, the latter giving alike shelter, grazing, and wood, besides causing a saving of manure to the land. Still, much has been done in the past, and more may yet be done, to mitigate the differences resulting from the existence of this class of physical causes.

The people in certain dry localities have dug wells, constructed tanks, and taken channels off streams.

On the other hand, in some parts, valuable land has been recovered by means of drainage, or by the construction of dams, made either by the people themselves, or by the Government through their engineers.

Encouragement has been given, and increased encouragement should be given, by Government to the extension of minor works such as the foregoing. Where, however, the effects are widespread, it is only by large measures, such as the State alone can carry out, that the mitigation of existing differences can be accomplished. Of such nature is the construction of canals by the State.

In the matter of wood and grazing supply, natural differences have, in many parts, been intensified through the reckless extermination of forests by the hand of man, or through excessive grazing with cattle and sheep, and more especially by goats. But although the people are likely to do little to remedy, yet it is in the power of Government to save what is remaining, and to provide "reserves" for wood, fuel, and grazing, whereby, too, the supply of manure to the land may be saved.

It becomes therefore, one of the most important duties of Agricultural Departments to ascertain and point out what measures are possible for the judicious modification, through Government agency, of differences resulting from such physical causes as the above named. This can only come as the result of close and careful enquiry as to what the needs of each locality are, and how they may be best supplied.

- (b) *Economical or Political Conditions*.—There are causes to be met with, e.g., in parts of the Central Provinces, of Bengal and of Madras, where, owing to the natural richness of the soil the sparsity of population, or other causes, there is not the same struggle for existence as is felt elsewhere and, as a consequence, the agriculture is often found to be inferior.

Modification of these differences by the people

Modification by Government

Duty of Agricultural Departments to ascertain and point out what measures are possible

Need of enquiry

(1) Economical or political conditions

Here the change will only come with the inevitable disturbance which time and increasing population will cause in the easier circumstances under which the people in some parts live at present, as compared with those in others. The increasing of these services.

III. Differences arising directly from want of Knowledge: III. Differences

There are many instances of the cultivation of one district being inferior to that of another, not on account of caste differences, nor yet on account of external and unfavourable physical surroundings, but simply because a better practice—I speak of Indian, not English, practice—has not been known. Or, again, as I shall have cause to show, an implement is not in use in a district, though employed advantageously elsewhere, or cattle are poor because not properly fed, or manure is wasted (more especially the urine) because there is no litter to conserve it, or crops are inferior in yield because seed is not carefully selected.

The want of knowledge, and the lessening of the local differences arising therefrom, cannot be supplied directly by the people themselves, but they may be by the State, partly by means of Education, and partly by the introduction of better methods from localities where they are known, to those where they are unknown, but their application to which is both feasible and desirable.

Their modification by the State—
 (a) by Education
 (b) by transfer of agricultural methods

This cannot be done without that "systematic prosecution of agricultural enquiry" which is so strongly insisted on in the Government of India's Resolution of December 1881, and which, as is rightly urged, "must precede any attempt at agricultural improvement."

It is the positive duty of Agricultural Departments to which

Such an enquiry, in anticipata my final recommendations, can, as the foregoing Resolution indicates, only be efficiently carried out by "a permanent agency" closely associated with the existing authorities in "each Province." Further, as I shall point out in subsequent chapters, I think that the assistance of an expert with special knowledge of the application of chemistry to agriculture is desirable in any such enquiry.

CONCLUSIONS

CONCLUSIONS

21. Owing to the great diversities met with in India, not alone in the physical features of the country, but also in the people themselves and in their varying surroundings, it is very difficult to speak generally of the condition of the agriculture. While in many parts it may undoubtedly be possible to effect improvement, it is not possible to do much, if anything, in others. Moreover, in every case it will be necessary to enquire carefully into existing conditions and practice before any real improvement can be carried out. That differences of conditions and practice do exist, constitutes, in my opinion, a ground of belief in the possibility of improvement, and it will be by the modification of these differences, and the transference of indigenous methods from one part of the country to another, rather than by the introduction of Western practice, that progress will be made and agriculture be bettered. This work will be done, (a) slowly by the people themselves, as they gradually come to see the necessity or the advantage of adopting the more profitable methods, (b) more quickly by the State, in the spread of Education, whereby prejudice will be broken down, and the benefit of better methods be made known. The introduction of such Western practices as may be found suitable to the case of Indian agriculture must also be the work of Government. Certain positive measures, such as the digging of wells by the people, the construction of tanks, etc., when found to be suitable should be more persistently encouraged by the State, while major works, such as the making of canals, the provision of timber, fuel, and grazing, must be carried out by the State itself.

As a preliminary, however, to obtaining any real knowledge of the agricultural condition and needs of any district, there must be "a systematic prosecution of agricultural enquiry," such as is insisted on in the Government of India's Resolution of December 1881, and to this end there should be a permanent agency for the purpose in each Province. Lastly, I think that in any such enquiry the assistance of an expert with special knowledge of the application of chemistry to agriculture would be very desirable.

RECOMMENDATIONS.

RECOMMEN-
TIONS.

22. I recommend, therefore :—

The spread of General and Agricultural Education.

The establishment of an organised system of Agricultural Enquiry.

The active prosecution of positive measures already ascertained to be beneficial, and their further encouragement by the State.

I proceed now to consider, in reference to the subjects indicated in paragraph 18, the agricultural conditions of the country as they have presented themselves to me, giving at the close of each section such suggestions for improvement as appear practicable.

23 As mentioned already, there are great differences between the various castes and races of India in respect of their cultivating abilities, differences which are inherent to the people themselves, and which are consequently difficult to level. Yet the very existence of these differences gives a decided encouragement to the belief in the possibility of improvement, for it would proceed on what, after all, are the right lines when dealing with Indian agriculture, *viz.*, to improve it from within, and by means of its own examples, rather than by bringing foreign influences and methods to bear upon it. The fact that a cultivator in one place, or, better still, in the same village, can act as an example to another elsewhere or co-resident, may provide, if rightly followed up, a far more useful and less expensive practical proof of the possibility of improvement than a Government Experimental Farm. I remember being much struck by seeing, amidst the numerous wheat fields surrounding a village in the Central Provinces, a small holding of an acre or two, where, unlike elsewhere around, a well had been dug. The crops here were far more varied in character, sugar-cane and vegetables of many kinds were growing, and what water there was still to spare from these crops was being utilised for a wheat crop situated on the outskirts of the holding. I measured the standing corn, and found it to be then (February 23rd) 3 feet 8 inches high, whilst the wheat on unirrigated land adjoining was only 2 feet 1 inch high. On enquiry I found that the holding belonged to a man of the Kachhi caste, and when I expressed wonder that other cultivators did not follow his example, the answer given me was, that they were "wheat growers," and that it was not their "custom" to grow other crops. Although necessity had not yet obliged others to adopt an improved practice, there was an instance afforded here of what might be done if the necessity arose, the improvement having its origin in a purely native source.

24 The subject of "caste" is one of much complexity, and demands for understanding it a very extensive knowledge of the country. I can, therefore, say but little about agriculture in its relation to, and as affected by, caste. As mentioned in paragraph 20, some castes are hereditarily inferior as cultivators to others, but the agricultural practice of any one caste is not uniformly alike everywhere, nor equally good. The Jats, for example, are spoken of in the Meerut district as being "unsurpassed as cultivators," but

in the Bareilly district they are not so good, and the Kurmis and Lodhas are superior to them there. The Rājputs and Brahmins do not themselves, as a rule, cultivate, but they employ hired labour, in some parts, however, they are described as being "moderate cultivators." Not only are there differences of caste, but there are also differences of race, as exemplified in the Kols (the aborigines of Chota Nagpur), the Bhils of Bombay, and others. Again, there are castes and races distinguished for the special branches of agriculture which they practise, or for the particular methods they employ, such are the Kēerns, who are mostly growers of vegetables, the Kurmis, Lodhas, and Malis, who are largely market-gardeners, the Kāchhis, who, in their cultivation, use the night-soil of villages and towns, the Velloia caste, again, are cattle breeders, the Gavhis are suppliers of milk, and also breed their own cattle, the Gujars, Vanjars, and others are graziers.

25. Bearing in mind the method set forth in the last chapter, I shall confine myself to considering how far improvement in agriculture may be effected through the lessening of those differences which are directly due to caste or race prejudices. The further question of the improvement of the cultivation of one locality by the importation into it of the practice of another, is one not directly connected with the inherent differences of cultivating classes as such, and will be dealt with elsewhere.

26. That the breaking down of caste prejudice would be followed by considerable improvement in agriculture admits of no doubt, and needs but little discussion. Could the Rājput or Brahman be brought to see that there was nothing derogatory in manual labour, or in taking an interest in the cultivation of the soil, could other cultivators be led to follow the practice of the Kāchhis, and abandon their prejudices against the use of night-soil as a manure, they could then raise crops such as the Kāchhi does, and the country would be greatly benefited thereby.

In the course of my first tour Sir Edward Buck pointed out to me a village, named Singboudi, in the Doab, where the former tenants, who happened to belong to a low caste (Kurmi), had worked so industriously and profitably that they had actually been able to buy out the original proprietors who were of higher caste (Rājput), and had become possessors of the village themselves.

The town of Farukhabad, again, is surrounded by a perfect garden, the result entirely of Kāchhi cultivation. When, about twenty years ago, Sir Edward Buck transferred some of these cultivators from Farukhabad to Cawnpore, they showed at the latter city how a profitable use could be made of what would otherwise have been a public nuisance, and also how the State revenue derived from the area they cultivated could be very largely increased.

How breaking
down of pre-
judice may be
brought about—

(a) by the
people them-
selves

(b) by the force
of circum-
stances

Indications of a
change going on

27 The breaking down of caste prejudice in agricultural matters may proceed slowly from the people themselves in the gradual abandonment of inferior practices in favour of more profitable ones, but it will be brought about more rapidly by the force and exigencies of circumstances which call for greater attention being paid to the cultivation of the land. Already there are indications of a change going on. It has been mentioned by castes who used formerly, and that the prejudices also largely disappeared.

Some eight or ten years ago a batch of Kachhis from the North-West was transferred to Nagpur, in the Central Provinces. Not only did they continue to employ their particular practice with profit, but other cultivators around followed their example, amongst these being even Brahmaas. The latter began to grow sugar cane and vegetables of all kinds, just as the Kachhis had done. Their cultivation is still inferior to that of the Kachhis, but, nevertheless, a beginning has been made in the way of improvement, and this has originated entirely from the example set by the Kachhis. I might instance, too, the sugar cane cultivation around Poona. This was commenced by a Brahman who first showed the Municipality how to make "pondrette" out of the night-soil of the town, and then taught the Hindu cultivators how to use it. This "pondrette" is now used to an enormous extent. At Nagpur, again, I saw Brahman lads engaged in cultivating, they work with the plough just like the other pupils of Mr Fuller's Agricultural Class, indeed, Mr Fuller makes it a *sine qua non* that they should do so.

In the Kapurthala Administration Report for 1890, page 36, Major Massy writes "The Rajput is proud, idle, and not 'thrifty' but still is a better cultivator than his forefathers were, he goes out to his fields more regularly and begins to realise that he must earn his living by the sweat 'of his brow'." In the Hoshiarpur Settlement Report it is stated that some of the Brahmaas and Rajputs will now plough their lands with their own hands.

Thus it is clear that a change is going on.

Progress of
improvement.

28. The work of improvement by example may be, and probably will be, a slow one, and where circumstances (as in the case I have cited from the Central Provinces) do not call for the positive necessity of arousing themselves to better their agriculture, the higher castes or the more easy going cultivators may hold to their old ways, still, there is undeniably a tendency, wherever pressure has begun to be felt, for the inferior cultivating classes to adopt the practice of the superior and more thrifty ones. When once a change of this kind has set in, its progress is, as a rule, rapid. I need but instance the case of Amritsar, where, though but a short time has elapsed since their introduction, vegetable-growing and market gardening are now carried on most extensively, and almost entirely by the utilization of the night-

soil of Amritsar as manure, in conjunction with canal irrigation. It would, not long ago, have been considered impossible for this to happen, or for night soil ever to be turned to a profitable use on account of the prejudices of the people against it. These prejudices still exist in many places, but I am convinced that they must give way, as they have done already, especially when the necessity of increasing the yield of the land is forcibly brought home.

Improvement by force of example is not confined to native methods only, for, as Mr. R. H. Elliot pointed out to me, coffee-planting by the Natives has improved very considerably in Mysore since European planters settled in the country and introduced better systems. The same remark applies to the cultivation and manufacture of indigo since English planters came to the districts where the plant is grown.

29 While the remedy for inferior cultivation will be found largely in the exigencies of circumstances which demand more attention being paid to the land, it is in the weakening of those caste prejudices which account, in no small measure, for the differences between good and bad cultivators, that Education plays a most important part. Already its influence has been felt. I have noticed above the case of the Nagpur Agricultural Class, and I might say the same in regard to the Poona College of Science and other institutions which I have visited. The spread of Education will be one of the most potent factors in creating that interest which agriculture, from its widespread extension and importance as the staple industry of the country, both merits and demands. It is therefore, through Education that Government can aid largely in lessening those differences which are at present inherent to the cultivating classes as such, and which stand in the way of agricultural improvement.

The influence of
Education

The work of
Government

CONCLUSIONS

CONCLUSIONS.

30 Improvement in agriculture, through the modification of differences due to caste and race prejudice, may be effected by the gradual breaking down of that prejudice. This will result partly through the people themselves in their adoption of more profitable practices, partly from the force of circumstances obliging greater attention to be paid to the cultivation of the land.

Government can greatly aid, through the spread of Education, in weakening caste prejudice.

RECOMMENDATION

RECOMMENDATION

31 My suggestions under this head accordingly resolve themselves into—

The desirability of extending General and Agricultural Education

CHAPTER IV.

CHAPTER IV

CLIMATE

CLIMATE.

32. This all important factor in Indian agriculture is, unfortunately, one that can only be altered or modified to a limited extent. Interesting, therefore, as a study of the influence of climate on agriculture may be, we should, nevertheless, be dealing with one of those elements which the cultivator finds in *limine*, and in accordance with, and not in opposition to which he must frame his practice, because neither his energy nor the help of the State can to any great extent modify its conditions. It will, therefore, not be necessary for me to go deeply into this part of the subject beyond touching on a few striking instances of the effect produced on the practice of agriculture by differences of climate.

33. As explained in the "Statistical Atlas of India," it may be said that over the greater part of India there are three well-marked seasons, *viz*, the rainy season (June to October, inclusive), the cold season (November to February, inclusive), and the hot season (March to May, inclusive). The two former are due, respectively, to the prevalence of the south-west and the north-east monsoons, whilst the hot season marks the transition from the cold to the rainy season. Yet these alone do not determine the kinds of crops grown, and we do not find in all parts alike that there are crops corresponding to the different seasons. The relative dryness or dampness of the climate has also to be considered. Through the kindness of the Government of India, I have been enabled to consult the atlas of maps illustrating the climate of India. These have been especially the corresponding maps in the "Statistical Atlas of India," and accompany the present Report. A reference to the Rainfall Map will here help to explain the remarks which follow. The contrast between climates is more marked in Northern than in Southern India. In Southern India, generally, it may be said that there is uniform warmth, with dampness towards the west and dryness in the east and interior, but in Northern India we find every variation, from the dry climate of the West and North-West, accompanied by marked differences of summer heat and winter cold, to the permanently damp climate and heavy rainfall of Assam and Eastern Bengal, where the differences of temperature are not so extreme. So it comes about that, whilst in the North-West and Northern India generally there are two clearly defined crop seasons, *viz*, the rainy season (*kharif*) and the cold season (*rabi*), we find that in Madras these distinctions

Effects produced
by climate on the
crop-seasons.

disappear, and we have only early and late sowings of the same crops. In Behar and some other parts of Bengal there are three rather than two seasons, with their attending crops, *viz.*, the early rainy season (*bhadai*), the late rainy season (*aghani*), and the cold season (*rabi*).

Great variation
in rainfall of
different parts
as shown in
"Statistical
Atlas of India"

Relation of rain-
fall to famines

"Protected"
and "preca-
rious" tracts

34. The Report of the Famine Commission abounds with instances proving that famines are the result of one cause alone, *viz.*, failure of rainfall. A reference here to the Rainfall Map will show how very varied is the distribution of rain over the country. In Burma, Assam, Eastern Bengal, and along the coasts of the Western Ghâts there is abundant rain; also a rain tract exists along the foot of the Himalayas. In the Central Provinces, too, there is a plentiful rainfall. It is these parts, therefore, which are the most free from famine. So, again, but for a quite different reason, are the very driest regions of all parts of the Punjab, for example, since there the *ratgals* will never try to grow a crop or to cultivate unless there is a certainty of water supply. The most precarious tracts are those where the chance that enough rain may come gives a temptation to venture on growing a crop, and then, if drought intervenes, there is a total failure of harvest. These are the parts which are light-coloured on the Rainfall Map.

Illustrations of
the effects pro-
duced by climate
on the practice of
agriculture in
different parts

35. The dependence of certain crops on heavy rainfall and a damp climate is well marked in the case of tea culture in Assam, where the annual rainfall is from 90 to 160 inches or more, and in that of indigo in Behar, or of rice in Bengal and on the Western Coast of Bombay. Other crops, such as gram (*Cicer arietinum*) and arhar (*Cajanus indicus*), can, on the contrary, do with a minimum of moisture, and flourish in a hot, dry climate, such as that of the North-West. Whilst the damp climate of Behar and Bengal favours the growth of the indigo plant but not the ripening of the seed, the hotter and drier climate of the North-West Provinces or the Punjab causes the seed to yield well there, and the two cultivations are, for the most part, carried on in separate Provinces. With wheat growing we have marked contrasts of climatic surroundings, as shown, on the one hand, in the case of the plains of the Punjab and North-West Provinces, and on the other, in the wheat districts of the Central Provinces. In the former, dependence is placed largely upon irrigation, for the soil soon loses its moisture and becomes baked, indeed, one may sometimes see (as I myself saw) a wheat crop on which not a drop of rain had fallen from time of sowing to harvest, so that, were it not for irrigation, famine might be ever at hand. In the Central Provinces, on the

for cold-weather crops.

Going southwards, as I did in my second tour, from Delhi, through Rájputana, and down the western side of the Bombay

Presidency, along the north of Madras, then to Bengal, and returning finally to the Punjab, I had abundant opportunities of seeing how systems of agriculture must be varied according to the climate. Passing from the hot plains of Rajputana, with its sparse cultivation and low rainfall, one comes to districts of heavier rainfall, say 60 to 80 inches, such as Baroda, Nadiad, and Mahim, where rice will grow without irrigation, the rainfall alone sufficing, at Kalyan and Igat-puri (nearer Bombay) the rainfall varies from 100 to as much as 150 and 170 inches annually, and the *red** system of making the rice seed bed is in vogue, whilst it is not employed in districts of lighter rainfall. Grass headlands and live hedges are also features of many of these parts. If, however, we go inland to the Khândesh (Deccan) district, we find a rainfall of but 30 inches and the crops quite different, rice being replaced by cotton and millets principally, wheat also coming in. On the southern side of the Bombay Presidency districts are successively passed in the journey by rail which have an increasing rainfall, from the Kistna Valley, where it is 40 inches, to Belgaum with 65 to 80 inches, while only another 20 miles or so further on it is as much as 150 inches annually. In each district the cultivation is different, rainy-season crops being distinctive of the first named, except where patches of black soil interspersed among the other (which is mainly red) enable moisture to be retained for growing cold season crops, such as wheat and gram. In Belgaum, as also in Dharwar, the exceptional feature of hot-weather rains in May allows of the early sowing of rice for the heavy rains later on can always be depended upon, but *red** is not practised, whilst in the extremely rainy and unhealthy region nearer the Western Ghats it is. On the red soil of Dharwar, with a rainfall of about 45 inches, rice is, as mentioned, grown early, but on the black soil nearly all the cultivation is that of dry crops. Going on into the Madras Presidency, we find fresh factors regulating the crops that are grown, for not the south-west monsoon alone, but also the north-east monsoon plays an important part, and when the former fails, the cultivators wait for the second, and have thus a double opportunity of sowing. Again, in Madras there are not the wide divergencies of temperature that occur elsewhere, but a more regular and continuous warmth exists throughout the year, and so it may be said that the crops, to a considerable extent, go on independently of season. To pass from such conditions as these to

its rice and jute

Punjab, implies

re Even in the

rainfall from the

7 inches found in the arid tracts of Multan and the 14 inches in Hissar, to the 26 inches of Amritsar, or the 35 inches of Hoshiarpur, the surroundings of agriculture must affect its practice vastly

* *Red* system — Alternates layers of cow dung, topplings and leaves of are spread up on the ground which is to form the seed bed and the who the ashes is mixed with the soil

and as the
is to and

To the first-named district canals are absolutely necessary for the purpose of cultivation, in the last named the water-level is quite near the surface of the ground. In yet other parts, such as Hissar, where there is great want of water, and not sufficient for the sowing of winter crops, nearly all the crops are rainy-season ones.

It is remarkable, too, how within quite a limited area the rainfall will vary. The following instance has been given me by Mr. J. J. Macleod at Segowhe, in Behar, it is 80 inches yearly, at Rajghat, 9 miles to the west, 47 inches, at Beyraah, 5 miles west of Rajghat, 36 inches, and at Mallah, 5 miles south west of Beyraah, 26 inches, whilst at Dhodkharah, 6 miles north of Segowhe, it is 66½ inches.

Effects produced
by climate on the
cattle and
people

36 But it is not in the crops alone that the influence of climate is seen, it is exemplified strongly in the case of the cattle, and even in the people themselves. It is only necessary to mention one single illustration out of many, viz. the wide difference between the diminutive bullocks and cows of Bengal where a damp, hot atmosphere prevails, and the fine, large strong cattle of Hissar and other dry parts of the Punjab. In the latter Province the atmosphere, though hot is clear and dry, and the soil is far more adapted to the breeding of cattle than are the damp regions of Bengal. We see, however, the reverse in the case of buffaloes, as no climate seems too damp or so-called too heavy for them. Thus, at Mahim (Thana district of Bombay) the buffaloes are magnificent, but the other cattle are poor and miserable, so, too, is it in Eastern Bengal, in Behar, where it is drier, the plough cattle are again superior. Buffaloes are the principal plough cattle throughout the districts of heavy rainfall below the Western Ghâts, here the preparation of the rice fields, covered as they are with water to the depth of several inches, could only be carried on by means of buffaloes. In the Punjab fine buffaloes may be seen, it is true, but it is as a milk giver that the animal is esteemed there, and its excellence depends upon the practice there in vogue of growing fodder-crops for the cattle, and of driving the buffaloes to the forests or to the river banks to remain there during the hottest months of the year.

What is true of the cattle in respect of diversity produced by climate is true also of the people. The inhabitants of the dry, and at times cold, Provinces of North-Western India are far stronger and more active than those of the always damp and warm Provinces such as Bengal, although in these latter the people are the more mentally acute. Their respective foods have undoubtedly also to do with these differences, but the foods themselves must be considered as determined by climate, for it is alone in the cooler and drier climate that wheat will flourish, while rice rejoices in a damp, warm climate such as that of Bengal.

37 I said at the opening of this chapter that climate is one of the external circumstances influencing agriculture, in which changes can only be effected to a limited extent. It is im-

Elimination of
2 "circumstances"
resulting from
climate impossible

possible, therefore, to eliminate the differences that result from it; the most that can be done is to mitigate their influence. In two directions, possibly, there is some hope of doing this:—

Firstly,—by the supply of Canals and other means of Irrigation to the drier tracts of the country;

Secondly,—by the preservation of Forests and the creation of “reserves” of Wood and Fodder.

It consists of the 4 Reserves—

1st) by Irrigation

2d) by preservation of forests and creation of “reserves” of wood and fodder.

To such supplies as the last-mentioned the name of “Fuel and Fodder Reserves” is generally given, and will be used throughout this Report.

38. The beneficial influence of irrigation in dry tracts is obvious, but that resulting from the growing of trees needs some explanation.

Beneficial influence of trees

It has been much debated whether forests and plantations do actually bring about an increase of rainfall or not. But I would point out that their real influence and value consist in their *lowering the temperature*, and thus causing moisture to be deposited where otherwise it would pass on. As a consequence of this, forests and plantations will cause rain to fall in gentle showers instead of in heavy and often destructive deluges. Thus, a given quantity of rain will be distributed over a greater number of days, and its value to the agriculturist will be thereby largely increased. The true test of the value of afforestation in this connection is, not so much whether the *total* rainfall be increased, but whether the *number of rainy days* be more. The downfall is also increased in the neighbourhood of trees, and this has considerable agricultural importance, too.

It has not unfrequently been observed that in times of drought there has been plenty of rain in the clouds overhead; what was wanted was some agent to condense and “bring it down.” Trees would materially assist in performing this. Again, the difference between the action of a gentle rain and that of a heavy deluge is very marked; for, while in the former case the water soaks gradually into the soil, in the latter it rapidly runs off the *baked surface of the earth*, and very often causes much damage by the destruction of roads, the washing away of bridges, and the silting-up of tanks.

Through the kindness of Mr. Robert H. Elliot, of Mysore, I am able to supply a practical illustration of the value of woods, and one which would show that, in regard to rainfall, a climate can be favourably influenced in about 25 years.

Increase of rainfall in Neilgherry, through tree-planting.

Mr. Elliot, when in the Neilgheries in 1891, carefully examined, with the aid of Government officials, the Rain Records from 1870 to 1890. Previous to 1870 Octacamuod and its neighbourhood were nearly bare of trees, so much so that a photograph taken about that time has no resemblance whatever to the now thickly-wooded Station, the result of a large

amount of planting, both by Government and by private individuals. The returns show that, taking first the rainfall for the months of March, April, and May (when the rains are purely local), there were, during the five years 1870-4, 121 rainy days in all, while in the same months of the five years 1886-90 (by which time the Station had become fully wooded) there were no less than 147 rainy days. Also the increase of rainfall for these months during the period 1886-90 has been about three inches a year, a not inconsiderable difference, though, from an agricultural point of view, the distribution of rain over a greater number of days is more important than a mere increase of rainfall. Again, taking all the months of the year except June, July, and August (which are excluded because the rains of this period are not local in origin, but are those of the south-west monsoon and come from a distance), it was found that during the treeless period 1870-4 there was a total of 374 rainy days only, whilst during the wooded period 1886-90 there were 416 rainy days. Further than this it was ascertained that the character of the rainfall had altered within late years, light and regular rain showers taking, to a great extent, the place of destructive occasional torrents. The agricultural importance of these facts is very great, indeed.

Other benefits
attending tree
planting

But there are other indirect benefits attending the spread of tree planting, benefits affecting the soil itself more particularly. What trees do is to hold up the soil, preventing it from being washed away and carried off by streamlets, next, a coating of vegetation soon covers the soil on which trees are growing, and binds it together, though at the same time rendering it permeable to and retentive of, moisture, so that the rain no longer flows off as it would over a hard, dry surface without benefiting the soil below. Thus, a cool surface is produced in place of an otherwise dry and heated one on which the sun's rays would impinge directly, and from which they would be reflected, shade and shelter are provided, and in the end a moister climate will prevail. From old records and descriptions of India there is reason to believe that the climate was not formerly what it now is, hot that the spread of cultivation, accompanied, as it has been, by the wholesale and reckless denudation of forests and wooded tracts without reservation of land to afford wood or grazing, has done much to render the climate what it now is. Sir William Denison states that, when Governor of Madras, he was shown districts in which the rain had retreated as the forests had been cleared back, and he points out that when a rain-carrying cloud comes in contact with the bare and heated soil the tendency is for the moisture to be held up in suspension in the air, and not to be deposited on the earth. Such districts were found in Cuddapah, Madura, and Travancore.

Instances

1 Madras

2 Cairo

The case of Cairo has been instanced in support of the view taken as to the beneficial effect of trees, since plantations have

been established there a rainfall has appeared, whilst before this there was none. It is impossible, however, to say how far this result is due to the planting of trees, and how far to the opening of the Suez Canal, which latter is known to have caused distinct climatic changes.

When visiting Etawah (North-West Provinces) I went to see ^{3 L. Lawh} a plantation for the supply of wood and grass, this had been established about five years previously on land which was nothing more than bare ravine land. The whole extent of the plantation was 7,000 *bighas* (4,375 acres). I was assured that the Station had not been so hot since the plantation had been formed, and, anyhow, it is very certain that the now wooded and grass-covered ravines are very much cooler than the former bare, open spaces were. At Jhansi I was told the same thing, and that since the introduction of the system of *bunding** the streams and planting the slopes with trees, the Station had been cooler.

I am reminded here of an old Sanskrit saying which describes the rainfall as being divided into twelve parts, and assigns them as follows: "Six for the sea, Four for the forests and mountains, and Two for the land."

39 Though immense tracts of country have been denuded ^{Work of Forest Department in connection} in the past, there are still considerable areas which can be taken up and rendered serviceable for climatic ends, and the Forest Department has stepped in none too early in the endeavour to save those wooded tracts which are still left. From climatic considerations alone, the work of the Forest Department is, accordingly, of importance.

40 In addition to the protection of forests, and the reservation of considerable tracts for the creation of "Fuel and Fodder Reserves," there are other minor measures which have often been urged by the Imperial Department of Agriculture, and which, while primarily supplying timber and fuel, also exercise a benefit in the provision of shelter, shade, and coolness in the immediate vicinity. Such are the growing of trees along canal banks and railway lines, and the encouragement of Arboriculture ^{Other measures for supply of shade and shelter} by the planting of trees along the sides of roads. ^{Plant on Arboriculture}

These matters will be more fully dealt with in Chapter VIII, when considering the wood supply of the country.

41 But little help must be expected to come from the people directly, in the attempt to mitigate as far as possible the influence of climate. They are hardly likely to originate such measures as have been suggested, and they have not the means to carry them out. Too often, it is to be feared, they will even oppose the taking of remedial action, at all events at the outset. Such has been the case already with Forest preservation, and it will not be until they are convinced of the utility of the measures taken for their benefit, and for the improvement of their agriculture, that the ^{The application of remedial measures must be undertaken by Government}

* *Bund* or *banding*—holding up the streams that would flow over the land during heavy rain by means of embankments on which grass is allowed to grow and on which trees are sometimes planted as well.

people will accord their hearty support; the tendency with them will be, as it has been in the past, to clear and to destroy rather than to save and to plant. Something may be done by way of encouragement in offering rewards for tree-planting, but it is clear that the work, both of irrigation schemes and of maintenance and creation of wood "reserves," must fall to the share of Government

Duty of Agricultural Departments to enquire where remedial action should be taken

It becomes, therefore, the duty of Agricultural Departments, first, to make a careful enquiry as to the localities in which measures for mitigating the severity of the climate are most needed, then, to ascertain what the nature of such action is to be, and how it may be best applied. This can only be done efficiently by instituting an enquiry such as that I have drawn attention to in Chapter II, and by an "agricultural analysis" such as is sketched out in the Government of India's Resolution of December 1881 (see paragraph 4 of the present Report)

CONCLUSIONS.

CONCLUSIONS.

42. While the elimination of differences due to climate and affecting agriculture cannot be achieved, the mitigation of their influence is to some extent possible. This may be done by increasing the means of irrigation to dry tracts, and by preserving and extending "reserves" of wood and fodder. In these ways an improvement in agriculture may be brought about. Both measures are the work of Government.

RECOMMENDATIONS.

RECOMMENDATIONS.

43. I recommend:—

The extension of Canals and other means of Irrigation to the drier tracts.

The establishment, wherever possible, of "Fuel and Fodder Reserves."

The increase of Plantations along Canal banks and Railway lines.

The spread of Arboriculture.

The instituting of Enquiry by Agricultural Departments as to where the above measures are needed, and how they may best be carried out

CHAPTER V.

CHAPTER V.

SOIL.

SOIL.

Absence of
recent scientific study
of the soils
of India

44 THE soils of India have not, so far, been made the subject of careful or scientific study. A few analyses are recorded of the soils of particular spots, and on two of the Government Experimental Farms a practical analysis of the soil has been attempted by growing crops on them with the aid of manures in which certain chemical elements have been alternately given or withheld. This has, however, been done without a previous knowledge of the soil and its constituents having been gained, has not been definitely known how much of each chemical element was actually supplied in the manures, nor was there any subsequent soil analysis in order to see which constituents, and how much of each, had been removed by the cropping. Such experiments have a certain value, it is true, and may occasionally give some rough idea as to the needs or capabilities of a particular soil, but they fall far short of what may be gained by a systematic and scientific enquiry. I do not wish, however, to attach too high a value to the mere chemical analysis of soils as the index to all soil improvement, knowing well, as I do, the difficulties of interpreting the results aright, and, especially in the case of India, of applying the results in the form of recommendations that will be practically useful. It is not enough to ascertain that a particular ingredient may be wanting in a soil or be beneficial to a crop, but it is necessary, too, to know in what practical and most economical form that ingredient may be supplied, and whether, in effect, it will pay to apply it at all. In this respect India is very differently circumstanced to England, America, and other countries. Not only is there an absence of large landowners, but the few wants and scanty means of the cultivators, and the smallness of the holdings (averaging probably less than five acres each), make it necessary to consider measures of improvement from a special point of view. This has not been sufficiently borne in mind by those who have advocated "improved" implements and chemical manures for Indian agriculture. Even those (and Natives, too) who have lived in England or have gone there to study have been disposed to exaggerate the value of chemical manures and chemical analysis of soils. While urging, as I shall do strongly, the employment of chemical and analytical skill in connection with the investigation of the soils of India, and in agriculture generally, I must not lead those whom I am called upon to advise, to expect too much from the researches of an Agricultural Chemist. Analysis of soils may do much to explain phenomena, and to suggest the lines of improvement, but it can, unaided, certainly not reform Agriculture. There is, however, without doubt, a large field open for enquiry, wherein the assistance of chemical

Need of care on
to apply the re-
sults of scientific
enquiry to
indian agriculture

The real value of
chemical analysis
of soils etc

analysis will be positively necessary, but it must be employed in conjunction with an intelligent acquaintance with agricultural practice and with the needs and resources of the agricultural classes, an acquaintance which can only come from a careful and systematic course of enquiry.

45 In respect of different geological types of soil India exhibits far less variation than England. Soils of one main type, - - - infinitely wider areas, and - - - a single farm, necessitating - - - of particular crops on each kind of land, are not often met with in India. Reference to the Geological Map given in this Report will show that the divisions are few in number and little varied over the country. They may be said to consist of three different kinds only, marked respectively on the map, brown (alluvial tracts), green (black cotton soil), and red (hard rock). The vast alluvial plains composed of mud and sand stretch across the northern portion of the country from west to east, the second type or black cotton-soil is a basaltic formation, and occupies mainly the central and western divisions of the map, lastly, the hard, rocky type, composed of archæan and metamorphic rocks, covers the southern and south eastern divisions. In the next chapter I shall have occasion to point out how the effect of irrigation is altered by the existence of these different kinds of soil. Peaty soils are but little known in India, the chalky gravels and oolite soils, the marls and clays and other varieties met with in England are absent, in their place are found distinctive types in the "black cotton soil," in the presence of concretionary nodules of carbonate of lime called *lanakar*, and in vast alluvial plains and silt renewed tracts.

Variation in main types of land as is not so marked as in England

Geological Map in the Atlas of India

Types of soil

46 Although the main geological types of soils are not so varied as in England, there are a large number of subdivisions, known by local names differing in each district, but the respective qualities of which are quite clearly understood by the cultivators. These minor differences, the result of variations in climatic conditions, in the system of manuring, and in the greater or less prevalence of trees and forest in the neighbourhood, are more numerous in India than in countries of more uniform climate and more similar agricultural practice and surroundings throughout. In several Provinces a regular system of classification of soils exists, and is used for Settlement purposes, while each district has its own classification under the particular local names given to the soils in each. In some Provinces every field even is classed according to its position, the nature and depth of the soil, the crops grown on it (whether it be wheat or rice or "garden" land), its nearness to the village site etc, and particulars are recorded as to its being embanked, irrigated, or open to damage from water channels, and whether it be exposed to injury from wild beasts, etc.

Numerous subdivisions of soil in local classification

See ability of
Instructors
Revenue officials
in agriculture

47. On one occasion when I was in the Central Provinces, several Inspectors of Village Accountants (*palwaris*) and District Inspectors came to me, and, as we went over the fields together, I was much struck by the minute discriminations which they made between different varieties of soil, and by the interest which they took in this part of their work. They were, however, quite ignorant as to how soil came to be formed, and of the forces of nature, and of the causes which produce differences of soils. With a little sound instruction in agriculture, and in the elementary facts of science affecting it, these men would, I thought, have a much more intelligent understanding of agriculture, and of the conditions with which they have to deal in their daily work.

Improvement of
soil—the direc-
tions in which it
may proceed

48 I come now to the improvement of the soil. This must take one of two forms *first*, the rendering of cultivated land more productive, *second*, the reclamation of land, or the making fit for cultivation land which is now considered uncultivable.

Is the soil of
India becoming
exhausted?

49 Under the first head the question naturally arises—Is the soil of India becoming exhausted? This is not an easy question to answer. Time after time it has been pointed out to me that the same fields have gone on growing the same crops on much the same system as at present, for centuries past, it is averred, too, that, by rotation and fallows, the land receives the necessary change of cropping and the “rest” from cultivation which prevents it from going down in quality. Further arguments are, that the rainfall contains more nitrogen in India than in England, that the sun acts as a fertilizer, and so on. On the other hand, there is a pretty general belief that the soil is becoming less productive, and remarks to that effect occur over and over again in the Settlement Reports of most able officers, obliging me to conclude that they are more than mere casual observations.

Want of positive
evidence

When, however, one looks for positive evidence of soil exhaustion, I admit that it is not forthcoming. Still, this does not prove that exhaustion is *not* going on. The want of evidence is due rather to the absence of reliable records in the past, and to attention not having been paid earlier to the crop out turns. When the question as to whether the soil was deteriorating was asked by the Famine Commissioners, the reply received from Bengal was, that there were no means of ascertaining. This same answer might with truth have been given by all the Provinces, for the whole of the replies received were very indefinite, and dealt with surmises and with popular report rather than with actual facts. When investigating the subject myself, I hoped to find in Settlement Reports more definite information, deduced possibly from instances of assessment having been reduced, but, whilst a large number of instances are given where land had become uncultivable owing to the spread of the efflu-

effluence of soda salts known as *reh* * (the land so affected being called *usart*), there are but few cases mentioned in which actual deterioration of soil through continual cropping is stated to have taken place. Where, in the absence of *reh*, no assessment had been reduced, it is impossible to ascertain whether any of the many other influences, such as fall in prices of produce, want of rain, indebtedness of the cultivators, or oppression of landlords (*zemindars*), has been the real cause of the reduction granted, or whether actual failure in the productive power of the soil has been brought about.

It is hard to gauge out-turns, and to get to know what the soil is, by itself, capable of producing, or for what period the return from manured land will continue to differ from that of unmanured. Further, it has to be considered that as fresh land is broken up, the manure supply, always limited and insufficient, has to be spread over a larger area than before. The opinion of cultivators must, I know, be taken as worth little, especially if it be given at a time when a re-settlement is imminent, the other opinions which I shall presently quote I give without wishing undue weight to be attached to them.

Difficulty of deciding the question

On two points there is, however, decided agreement: *firstly*, that land newly brought under cultivation yields well at first, but that, after a time, the produce falls, and *secondly*, that, whether the soil be undergoing exhaustion or not, it is certainly not being enriched, nor is the average out-turn over the whole cultivated area an increasing one. This has led many to the conclusion that, while land newly broken up will yield largely for a time and then decline, this decline will not go below a certain level, and there it will stop. The instances of unmanured plots on the Experimental Farms at Rothamsted and Woburn, in England, have been quoted in support of this view, but these, though they show that, after a certain level has been reached, subsequent deterioration goes on very slowly, yet prove that it does go on.

Theory that soil salinized on proceeds to a certain limit and then stops

The results obtained at Rothamsted in the case of a wheat crop continuously unmanured for 40 years are —

Experience at Rothamsted

	Average produce of Corn per acre in Bushels
9 years 1844—51 (previous to commencement of experiment)	17
20 years 1852—71 (experimental period)	13.9
20 years 1872—91	11.1

That positive evidence of exhaustion in the soils of India is not yet forthcoming is no proof, therefore, that the process is not slowly going on.

* *Reh* — An efflorescence of soda salts which appears as a white crust on the surface of the soil and renders it unculturable. The soil is a principally impure carbonate of soda but sulphate of soda also occurs largely, and with them are found common salt and salts of lime and magnesia. See also paragraphs 67 and 74.

† *Usar* — Land impregnated with soda salts, as above and thereby rendered barren. See also paragraphs 73—76.

"to be manured), (3) cattle epidemics. The supply of manure is extremely "limited."

In another passage Mr. Basu says—

"Fallowing used to be done, but is restricted owing to pressure of "population"

From the replies to enquiries addressed by the Famine Commission I take the following.—

Central Provinces.—Mr. (now Sir Charles) Elliott in 1866 wrote —

"It stands to reason that land, even the black soil of the Nerbudda Valley, must deteriorate if it is cropped year after year without anything being returned to it. . . . As long as half the first class was uncultivated, and a new field could be broken up for every one thrown into fallow, the crops (of the Nerbudda Valley) are not likely to have deteriorated much. But when once regular cultivation set in, and the majority of the land came under the plough, a certain amount of

(f) Instances from replies to enquiry of Famine Commission as to exhaustion of soil in Central Provinces.

" . . . followed . . . go, is sup- . . . y . . . reckon the . . . idly from . . . even, that . . . exhausted"

Madras.—

11 Madras

"No Collector has reported that there has been deterioration of the soil within his own experience, but some are satisfied, from the enquiries they have made, that deterioration is going on. The question of deterioration does not specially arise in this Presidency with regard to irrigated land. On the contrary, visible deterioration is apparent chiefly in connection with unirrigated land newly taken up, and not infrequently relinquished again after some years in favour of another fresh field, or one that has had some years' rest.

51. The above extracts, while perhaps not furnishing absolute proof that the process of exhaustion in soils is going on, point to much more than mere probability of its existence. It must be accepted as an axiom in agriculture that what is taken off the land in crops must in some way be put back into the soil, or else the soil will suffer exhaustion. It is an equally accepted fact that the production of heavier crops means that more manure must be applied to the land. A country which exports both crops and manure must be declining in fertility. Now, what is the state of things as regards India? On the one hand there is a large export of oil-seeds, cotton, and other products, besides an increasing one of wheat, all of which remove a considerable amount of the soil-constituents. What is returned in their place? Only the straw or the stalks and leaves; and it is not even correct to say that these are returned, for, after all, it is only a portion, and frequently a very small portion, that does find its way back to the soil. Part is necessarily used up in the bodies of the cattle, part is wasted by imperfect conserving and storing of manure, part must unavoidably be lost, however great the care that may be taken; thus it comes about that it is only a fraction that

Under existing conditions of agriculture the soil of India must become gradually poorer

contributes finally to making up the loss the soil has sustained

Were, on the contrary, all grain to be consumed by the people, and all night soil to be used in agriculture, were all refuse of oil seeds (after pressing out the oil) to be utilised for manure, were all straw to be consumed by cattle, and the droppings, solid and liquid together, to be carefully preserved, lastly, were all stalks and leaves to be buried again in the land, then the balance might be more nearly preserved. But, as things are the exports of oil-seeds, grain, etc. (that of bones I will discuss later), simply mean so much of the soil constituents carried off, for which no adequate recompense is made.

The consequence must be that the soil becomes gradually poorer, though the effect may not as yet be visible to the eye, for, even if the soil be still producing the same crops, the *potential fertility* (by which I mean the reserve of constituents for the production of future crops) must be suffering loss, and the capabilities of the soil must be less than under a system of equal giving and taking. In face, therefore, of the enormous increase recorded in the population, and future increases that will have to be met, it becomes a most serious question how the food for these millions is to be found, in other words how the manure is to be obtained without which the crops necessary for feeding these people cannot be grown.

52 I cannot, therefore, agree with the theory that fixes a certain level to which production may sink, but below which it will not go. This is apparent rather than real. The decline may be slow, but this is a mere matter of time. When we compare the wheat yields of different countries, we have, as nearly as one can judge, the following —

TABLE I — Wheat-yields of different Countries.

	India.	United Kingdom.	France	Germany	Russia.	Canada.	United States of America.	Austria.
Average yield per acre in bushels*	10	24	17	15	9	14	12.5	11

* Taken from the Agricultural Returns of the Board of Agriculture 1873

† Average of the five years ending 1883-87 as given in the Government of India statement. The average yield in 1893-94 was 8 4 bushels per acre.

‡ Average of the last 40 years. The average of the last eight years was 30 bushels.

The wheat yield in India will vary, not only according to the season, but also with the conditions under which the crop is grown. For instance, it must be taken into account whether the land be manured or not whether it be land dependent on rainfall alone, or supplied by irrigation as well, and whether rainfall be sufficient or not. As nearly as a

The problem of
a future

Wheat yield of
different countries

conclusion can be formed, the following are the out-turns on some of the respective classes of land —

On unmanured dry-crop land where rainfall is precarious and often insufficient	-	-	-	-	7 bushels per acre
On manured land in tracts of better rainfall	-	-	-	-	10
On manured and irrigated land	-	-	-	-	15 to 25 bushels per acre

In comparison with the above, it may be mentioned that in the Rothamsted Experiments the produce of land continuously unmanured for 40 years is $12\frac{1}{2}$ bushels per acre, at 61 lbs. per bushel

53 The real answer to the question whether the soil of India is becoming exhausted or not, seems to me to lie in the fact of the small produce annually removed. In England, with its 28 to 30 bushels per acre, what is removed over and above the yield of the unmanured land is due to what is put into the land in the form of manure, India's 10 bushels, on the contrary, represent almost entirely what is taken out of the soil itself. The extra crop in England is, in other words, the produce of what is *added to*, and not, as in India, the produce of what is *taken out of*, the soil.

Possible explanation of any decline in soil fertility not being apparent, though really existent

Nevertheless, the powerful sun of India, aided by moisture, or by water (where it is applied artificially), exercises, I believe, a far more rapid and powerful influence in decomposing and bringing into an assimilable condition the constituents of the lower layers of the soil and of the stones and rocks which go to produce soil than is the case in England, and why no decline is noticed, after a certain limit has been reached, may be due to there being just enough fresh material decomposed and brought into active condition annually to produce the requisite small yield. It must not be forgotten, it is true, that the wheat crop of England is generally a nine months' crop, that of India only a five months' crop, but I believe that the influences named above are the most potent factors in causing the differences of yield. Were demand, however, made upon the soil for a greater yield, the soil could no longer supply it, and it would have to be met by outside sources, in other words, by manure.

Such a demand must be looked for in the rapidly increasing population, and in the greater difficulty of providing food for it. Sir James Caird, in treating of this problem, estimated that if the produce of the land could be increased by one or two bushels per acre the difficulty could be met. It will be my endeavour to show in this and the following chapters that the necessary increase can only be met in one way, *viz.*, by improving the *manure supply* of the country. Improvement in the system of land tenure, improvement of the land by expenditure of public and private capital on it, and similar measures, may alleviate the condition of the Indian cultivator, but they will not give him larger crops, and they will not

Importance of the question of manure supply.

provide the food that the people *must* have to live upon. For this the *soil* itself must be looked to, as it alone can produce the crops, and *manure* alone can enable it to bring forth the necessary increment. The question of manure supply is, accordingly, indissolubly bound up with the well-being and even the bare existence of the people of India.

Study of the
constituents of
the soil

54 Having considered the soil as a whole, and chiefly in regard to the important question of its deterioration or the reverse, it is well that I should now discuss the separate ingredients which go to make up soil, and which cause the difference between one soil and another. The main ingredients are the following—water or moisture, vegetable matter or *humus*, sand, clay, and carbonate of lime. These I shall take as presenting themselves in a chemical study of Indian as distinguished from English soils, and, in addition to pointing out the most characteristic differences, I shall endeavour to indicate possible lines of further enquiry.

1. Water or
moisture

Special import-
ance in India

55 First to be considered among the components of cultivated soil is Water or Moisture, without which no germination is possible. In India the relation of soils to moisture acquires a greater significance than almost anywhere else, on account of the rainfall being limited to particular periods, instead of being distributed throughout the year, and because of the intense and prolonged heat, with consequent rapid evaporation. Climatic conditions, as shown in Chapter IV, exercise most marked influences upon Indian Agriculture, and cause the practice of it to vary greatly in different parts.

Relation of soils
to moisture

A striking difference is seen between the condition of English soils and that of the generality of Indian soils. Speaking broadly, it may be said that the normal state of an English soil is "wet," and that of most Indian soils "dry," and whereas, in the case of the former, the object is generally to get rid of the superfluous water by means of drainage, the difficulty in India is, as a rule, to keep the moisture in the land. The relative behaviour of soils to the moisture which falls on them in the form of rain, or which is conveyed to them by artificial means of irrigation, is, therefore, of great importance. The differences of geological types of soil mentioned in paragraph 46 must be here again borne in mind, and reference to the Geological Map will assist the explanation. The alluvial soil (coloured brown on the map) which occurs in the Punjab and North-West Provinces, under conditions of a dry climate, low rainfall, and hot sun, soon loses its moisture and becomes baked, so that dependence has largely to be placed on irrigation, and the more so where the alluvium (or mixture of sand and clay) is sandy rather than clayey in character. So, too, the hard rocky formation (coloured red) of Southern and South-eastern India calls for the same measures. But where, as in the Central and Western parts, the black cotton-soil (coloured green) occurs, we find a great difference, for this soil is naturally very retentive of

Black cotton
soil.

moisture, and as it dries it cracks into blocks which, though hardened and baked externally, will be found, on being broken open, to have enclosed moisture within them, and to have thus prevented it from being lost. So it comes about that there is always sufficient moisture for the germination of the seed, and for the growing of the crop. Irrigation, consequently, is not necessary in these parts, and famine is of rare occurrence.

There is another class of soil, that found in the tracts along the river beds of the large streams in the Punjab, which always has a sufficiency of moisture in it, although not actually inundated. With this exception, and that of the black cotton-soil, it may be said that in the majority of cases great importance attaches to the retaining of moisture in the soil. I have often been struck by the attention which the cultivator gives to this, and have noticed with surprise how, even under the influence of a burning sun, the land, by reason of the careful preparation given to it, is made to retain sufficient moisture to ensure the germination of the seed put into it, for, on turning up the earth to a depth of two, or at most three, inches, the precious water will be found in it. In indigo-planting this is absolutely essential, and great is the care taken to break up and pulverise each crust that forms on the surface. I cannot help suspecting that the system of shallow ploughing, as practised by the Native, and his aversion to ploughs that turn over a broad slice and form a wide furrow, may have something to do with this matter of the retention of moisture, and that the effect of deep ploughing would too generally be to lose the very moisture the cultivator so treasures.

Soil of tracts along river beds in the Punjab

Importance in most cases of retention of moisture in soil

Shallow ploughing

56. From the foregoing remarks it follows that one obvious direction in which improvement in soil can be effected, is the increasing of the supply of water to dry tracts, and thus of moisture to the land. The means by which this may be done will be more specially treated in the next chapter, and it will suffice here to say that for any work to be carried out on a large scale it must be done by Government or by Government aid.

Improvement of soil by increase of water supply to dry tracts

This the work of Government

57. While I have drawn attention to the importance of the retention of moisture in the majority of soils, it must nevertheless be remembered that this principle cannot be enforced everywhere, and that there are some instances of its misapplication, as in the making of canals where they were not really wanted. Orissa is a case in point.

Harm occasioned by over-irrigation

There is little room for doubting that, by the introduction of canals into tracts where there was no real necessity for them, the soil has suffered from the removal of its valuable constituents through the continual washing process to which it is subjected, and also that a system of over-cropping (beyond what the soil can bear) is frequently consequent upon the introduction of canals. Other results attributed to canals are, the spread of *rel* (see footnote, p. 37), the increase of fever through the raising of the water level of the country, and the destruction of wells.

These various points will be dealt with in the next chapter. It is necessary, however, to interpose here the caution that, while, in by far the greater number of instances, the supply of water to and retention of moisture in the land is of the highest importance, it does not do to lay down a universal rule, and there are cases where any further supply of water would be attended by positive harm, or where measures for the removal of water might even be called for.

2 and 3 Organic matter and Nitrogen.

Humus is not
F n and func
tione

Organic matter
and Nitrogen in
Indian soils.

58 The next soil-constituent to consider is that which is variably termed "Vegetable matter," "Organic matter," or "*Humus*." Along with it it will be convenient to take Nitrogen also, inasmuch as this constituent is, in measure at least, derived from *humus*. Though, apart from water, the carbonaceous constituents form the largest portion of ordinary crops, these are derived not from the soil but from the atmosphere, and therefore do not concern us so particularly here. But the vegetable matter or *humus*, which has its origin in the dead roots and leaves of a previous vegetation, or in a previous manuring with organic materials, exercises a distinct influence on vegetation, for, though probably not directly assimilable by crops, it is the principal nitrogenous ingredient of soils, and on being further oxidised will yield carbonic acid, ammonia, and, lastly, nitric acid. This is effected by means of a nitrifying organism or *bacterium*, which occurs in fertile soils, and most abundantly in the surface soil. The nitrates or salts of nitric acid thus produced are the form in which nitrogen can be taken up by plants as food.

There are also physical advantages in the presence of vegetable matter in soils, such as, the binding together of sandy soil, the retention of moisture, the increase of porosity in clay soils. Further, the presence of vegetable matter in the soil has an indirect influence on the climate, inasmuch as soils rich in it absorb more heat from the sun's rays than do light coloured, sandy soils, which are generally deficient in *humus*, and in consequence radiate out more heat.

On looking into analyses of Indian soils which have been recorded, and others which I have made myself, I find that, with the possible exception of black cotton-soil, Indian soils are generally very deficient both in organic matter and in nitrogen. The following analyses will illustrate this:—

TABLE II.—Organic Matter and Nitrogen in Indian Soils

	I Cawnpore Farm No 1 (S A Hill)	II Soil from Arrah Behar (E Kitch.)	III Soil from Si pour Behar (E Kitch.)	IV Damroon Farm Soil Behar (E Kitch.)	V, VI VII * Three S. Is from Wheat-growing Land in Sikra Distr. et, Punjab. (J A Voelcker)		
Soil (dried at 21° F) contained —	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Organic matter and combined water	2.23	1.74	2.77	6.63	0.63	2.67	0.65
Nitrogen	.024	.023	.033	.05	.07	.05	trace

* For full analyses see Appendix A.

In the foregoing analyses the organic matter is not stated alone, but along with it is the water which is chemically combined with the mineral constituents, and which is not removed at a temperature of 212° F. Accordingly, the organic matter appears more than it really is, but, when compared with ordinary fertile English soils, the quantities, with the exception of No IV, Indian soils generally deficient in organic matter and nitrogen read low, and in some cases extremely so. In every instance the amount of nitrogen is small, and considerably below that found in the average of English agricultural land.

A person with knowledge of agricultural chemistry will readily understand that such soils as the above can be considerably benefited by the application of cattle manure, by green-manuring, or by the use of other organic and nitrogen-containing materials.

The importance of nitrogen is emphasised when it is explained that in the case of cereals the assimilation of starch is dependent upon the amount of nitrogen supplied to the plant, and that it is the nitrogen which helps to bring the different mineral constituents of the soil into action. It is not enough to have mineral constituents present in the soil, but there must also be nitrogen in order to render them available for the plant's use Functions of nitrogen.

It becomes necessary, therefore, to enquire very carefully into the sources from which nitrogen may be derived, and whether the deficiencies already noted may not be made up in some way or other.

59 A considerable quantity of nitrogen in the form of ammonium and nitric acid is conveyed to the soil in rain. The knowledge of the importance of nitrogen, and of its frequent deficiency in Indian soils, has led to an incorrect idea that the rainfall in India contains much more nitrogen than it does in England and other temperate climes, and that by this means the deficiency of nitrogen is met, and this important element is supplied to the crops. This statement has been copied over and over again into books, and has been pointed to in support of another erroneous opinion, viz, that practically no loss is incurred by the burning of cattle manure so long as the ashes are used, because the nitrogen that passes off in the burning is supposed to come down again in the rain. I have paid special attention to examining the evidence on which these theories are based, and I have ascertained that the original analyses which gave rise to them were incorrect, in consequence of the impurity of the chemicals sent out from England. Dr Van Geyzel, Chemical Examiner for Madras, has been kind enough to give me the information on this point, and also his own later analyses, from which it will be seen that the amount of nitrogen in the rainfall, as now returned, was, in 1888, only one thirteenth, and in 1889, only one-twenty fifth portion ($\frac{1}{25}$ per cent) of what was stated to be the amount in 1835-86. The following are the results, and by the side of them are given those of more recent analyses of Erroneous idea that rainfall in India contains much more nitrogen than in England

rainfall made by Mr Warrington at Rothamsted, Hertfordshire, England:—

TABLE III.—Nitrogen in Rainfall of India and England

Nitrogen in Rainfall of India and England.	MADRAS	MADRAS	MADRAS	ENGLAND (ROTHAMSTED)
Rainfall in inches	84.77	84.48	43.38	29.27
Total nitrogen reckoned as ammonia lbs per acre	62.339	7.967	2.114	4.54

* Incorrect result

From these results it would appear that the rainfall in India, instead of having *more* nitrogen, has actually *less* than in England. I do not say absolutely that this is the case, for Madras may not be typical of all India. Besides, its situation near the sea causes the composition of the rainfall to vary greatly at times, and to contain more chlorides, especially at cyclone periods, than would be the case at inland places. What, however, I do say is, that it has not been shown that Indian rainfall contains *more* nitrogen than English, and the arguments based on the presumption that it *does* are altogether faulty.

Fixed on of
nitrogen from
the atmosphere

Percent nitrogen
in soil

Leguminosae in
India

60 If, however, not from the vegetable matter, because less in amount, nor yet from the rainfall, because not richer than in England, we are to look for a compensating supply of nitrogen for that removed in crops, there is still another source the importance of which has been brought to light by quite recent scientific investigations—the utilisation of the nitrogen of the atmosphere itself. The researches of Hellriegel, Wilfarth, Prazmowski, Nobbe, and others, and now confirmed by the further experiments of Lawes and Gilbert (which are still in progress), have fairly established the fact that, though plants have not the power of absorbing the free nitrogen of the air directly through their leaves, yet in the case of the *Leguminosae*, the nitrogen is fixed in the course of the development of the organisms contained within the nodules which form on the roots of the *Leguminosae*, and the resulting nitrogenous compounds are absorbed and utilised by the host, that is, the leguminous plant. At present the evidence indicates the probability that this action is limited to *Leguminosae* of the Sub order *Papilionacea*.

No enquirer going over India could fail to be struck by the enormous preponderance of tree, crops, and even weeds that belong to the Natural Order *Leguminosae*. Almost everywhere the *dabul* (*Acacia arabica*) is seen, with many other leguminous trees, gram (*Cicer arretinum*), *urhar* (*Cajanus indicus*) and numer-

ons varieties of pulses, indigo, etc., are among the commonest crops, and are all highly nitrogenous, lastly, leguminous shrubs and weeds abound, and are often spread on the land or ploughed in as manure. How can this be in a soil naturally poor in nitrogen? The recent investigations referred to point to a strong probability that the conditions of India are peculiarly favourable to the fixation of atmospheric nitrogen through the medium of the nodules that are known to form on the roots of certain of the *Leguminosæ* at least. Support is given to this by the fact that quite lately, in Germany, Nobbe and Frank have found these nodules on the roots of leguminous shrubs, as well as in the case of the clovers and pulses that form our ordinary European leguminous crops.

A fertile field for investigation is herein set forth, and India, to my mind, presents special advantages for the elucidation of the problem one which, when solved, will unfold much that is still unexplained in the advantages of rotation of crops.

61 The special case of black cotton soil and its properties has been mentioned, and this again, offers a field of enquiry, for its origin and its qualities are not fully understood. It is believed in some parts to be derived from basalt by surface decomposition, in others to be the impregnation of argillaceous earth with organic matter. Carbonate of lime is present to a considerable extent in black cotton soil. In depth this soil varies greatly, at Akola it is from 40 to 60 feet deep, but further away it thins out to 19—20 feet, and after that gets quite shallow. In the rains it becomes quite impassable. It is generally supposed to require no manure and to be incapable of exhaustion. That it has peculiar powers, there is no question, but that it is so rich in vegetable matter and in nitrogenous ingredients as to be independent of manure, I do not think. I have not had the opportunity of studying it specially, but I give the following results from an analysis of black cotton soil by the late Mr S A Hill, and from one which I made of a specimen of this soil from Akola, in Berar.

TABLE IV—Organic Matter and Nitrogen in Black Cotton-soil

	I Black Cotton-soil from North West Provinces near the Jumna (S A Hill)	II Black Cotton soil from Akola, Berar (J A Voelcker)
Soil (dried at 212° F) contained —		
Organic matter and combined water	Per cent 4.35	Per cent 3.83
Nitrogen	0.11	0.16

The amounts of nitrogen are very low, and though there is more organic matter than in the soils tabulated in paragraph 58, yet the quantities are not really large. Support is given

to my beliefs as to the condition of this soil, by the increasing practice, among the better cultivators, of manuring it. It was stated in Settlement Reports of the Nerhudda Valley some 25 years ago, that it was not the custom to use manure, but now in Saugor and Dimoh it is by no means uncommon to find manure used, and the people all say that they want more.

4 and 5 Sand
and Clay

62 From the organic portion of the soil we may now pass to the principal inorganic or mineral ingredients, *viz*, sand, clay, and carbonate of lime. According as the sand or the clay (which is, chemically, a silicate of alumina) predominate, so we find differences in the water-retaining powers of soils, for sand has the least, and clay the most, power of holding water. This is well illustrated in the alluvial deposits brought down by rivers and streams, and which form the vast Indo-Gangetic plain. These are composed of alternating layers of sand and clay, and as the transported materials, whether the heavier sand or the lighter clay, have been deposited on any spot to form there the surface soil, so may variations be found in the soil's water-holding capability. In parts, such as the sandy desert plains of the Western Punjab and Rajputana, the surface soil is principally sand, owing to its deposit there, while the finer and lighter clay has been carried on farther. Such soil, in the absence of water, is little more than desert land. In other parts, clay may predominate and water be better retained*. On the other hand, capillary attraction, or the force by which water is brought up from the subsoil to the surface during dry weather, is more active in clays than in coarse sands, and evaporation is more rapid from a consolidated surface than from an open and well-tilled one. So it is that the incrustations of soda salts known as *reh* (*see* footnote, page 37) are found on the clayey rather than on the sandy lands. Again, a sandy soil is a better conductor of heat than a clayey one, and, being thus more rapidly warmed or cooled than a clay, is not so likely as the latter to become "baked."

To show the variations that occur between soils even at no great distances apart, I give the following results from mechanical analyses by Professor Kinch, of Gloucester, of soils from Dumrao, Arrah, and Simpur, in Behar, sent to him by Mr. D. B. Allen —

TABLE V — Sand and Clay in Indian Soils

	I Dumraon Farm Soil	II Soil from Arrah	III Soil from Simpur
Soil (dried at 212° F.) contained —	Per cent	Per cent	Per cent
Coarse sand	10.3	28.6	27
Fine sand	8.0	3.0	46.3
Clay etc	81.7	69.4	61.0

* The alluvial plains of India may be said to contain four types of soil: (1) heavy loam of Beagal where clay predominates; (2) heavy loam with clay and some sand; (3) light loam in the inundated land of Northern India, and the soil remains in clods; (4) white loam of Behar and parts of the Punjab; here the clods fall to pieces; (5) very light sand and sand of some parts of the North West and the Punjab.

63 The remaining principal ingredient of soil is carbonate of lime. Reference has already been made to the peculiar concretionary form of limestone known as *kankar*, which occurs largely in India. These lumps are found near the surface and are, doubtless, the result of the evaporation of water containing in solution lime which has been obtained by the decomposition of the mineral portions of the soil. Now, lime works beneficially in many ways, it not only acts itself as a plant food, but it makes clay loud permeable to moisture, and enables it to absorb potash, ammonia, and other salts, whilst, not least of all, its presence is required in the process of nitrification, by which means nitrogenous matters in the soil are made available for the plant's use.

Speaking generally, lime is more plentifully distributed in Indian soils than in Europe. Some of it are not so frequently met with, however, which I have found, is in the laterite soil of parts of Southern India, such as the coffee-growing districts of Coorg and Mysore, and the tea plantations in the Neilgherries, where, I have reason to believe, a more abundant supply of lime would be decidedly beneficial.

The following analyses exemplify these points —

Lime in Indian soils

TABLE VI — Lime in Indian Soils

	I	II	III	IV	V	VI	VII	VIII	IX	X
	Black Cotton soil near the Jomra, N.W.P. (S.A. Hill)	Cawnpore Farm Soil (S.A. Hill)	Wheat soil from S. Punjab (J.A. Voelcker)			Dumraon Farm Soil (E. Kieck)		Coffee soils from Munjered, Mysore (J.A. Voelcker)		
Soil (dried at 212° F) contained —	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Lime (as calcium oxide CaO)	3.66	93	1.68	1.46	1.88	1.00	66	20	32	32

The amounts of lime in Nos I—VII, inclusive, are more than in most cultivated English soils, but in Nos VIII—X a marked difference is apparent. Of the majority of Indian soils it may, however, be said that they contain a sufficiency of lime.

Lime generally abundant.

64. Having taken now the principal ingredients of soils, we may pass on to those soil constituents which, whilst found in lesser amount, are, nevertheless, those which exercise a great influence on the productive power of soils. Of these the principal are phosphoric acid, potash, and soda, and they are the only ones that need be dwelt upon separately. Other

Iron, Alomina, and Magnesia.

* For full analyses see Appendix A

† For full analyses see Appendix B. These soils had been cultivated for 30 years previously and only had bones in small quantity supplied to them

constituents, such as iron, alumina, magnesia, etc., which are found in soils and which enter into the composition of plants, do not call for special reference. Iron is a widely-distributed element in soils, and occurs largely in the laterite soils of South-western India, notably in the coffee-soils of Coorg and Mysore. This laterite is a porous, argillaceous rock, impregnated with iron peroxide (hydrated), of which it may contain 25 to 35 per cent. Alumina enters into the composition of all clays, but magnesia, so far as I know, acquires no special importance in Indian agriculture. Magnesia appears to exist in sufficient abundance throughout, and more plentifully than in English soils.

10 Phosphoric acid in Indian soils.

65. Phosphoric acid I believe to be more abundantly distributed in Indian than in most English soils. There are but few analyses to refer to, in consequence of the absence of any investigation in India from the standpoint of agricultural chemistry, but what analyses there are seem to show that there is, happily, not that pressing need for the additional use of phosphatic, and, I may add, for mineral manurial elements generally that there is in England. In the latter country, if a soil contained 0.12 or 0.13 parts of phosphoric acid in 100 parts of the dried soil, this would be reckoned a good average amount, and 0.17 per cent would be decidedly above the average. From analyses of Indian soils I quote the following results, giving, for convenience, the determinations of potash in the respective soils at the same time —

TABLE VII.—Phosphoric Acid and Potash in Indian Soils.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
	Wheat-soils from Rivers Punjab (J. A. Voelcker)			Cawnpore Terra Soil (S. A. Iltis)	Dumraon Terra Soil (L. H. Koch)	S. V. from Allah. (S. Koch)	1012 & Cotton soil 17 m 114 Jomra, N. W. F. (S. A. Iltis)	Coffee soils from Mysore & Coorg (J. A. Voelcker)		
Soil (dried at 212° F.) contained —	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Phosphoric acid	17	23	19	21	19	28	21	13	15	10
Potash	39	74	51	33	153	50	23	25	79	70

Although variations are shown in these results as regards the phosphoric acid present, in no case are there the marked deficiencies frequently met with in England, and, taking the four first-named soils as representative of a great tract of wheat-growing land, I should consider them especially well supplied with phosphates. This may possibly have some

* For full analyses see Appendix A.

† For full analyses see Appendix B.

bearing on the question of the utilisation of bones in India as against their export. If a soil show no deficiency of phosphates, there may be in this the explanation of the fact that bones have not as yet been clearly proved to be beneficial or necessary to a number of Indian soils. The utilisation of bones as manure

On the other hand, the somewhat lower amount of phosphoric acid found in the laterite soils of Mysore, together with the greater demands of the coffee plant upon the mineral ingredients of the soil, may be the reason that bones are in these parts used extensively by the planters, and are considered necessary. The benefit of their application may be also in the fact that they supply lime and nitrogen as well as phosphoric acid.

66. Potash, like phosphoric acid, is a very important plant food. It appears to be well distributed, and its additional supply to be only exceptionally called for in Indian soils. For growing ordinary farm crops in England 0.25 per cent. of potash in a soil would be reckoned a fair amount, but, as will be seen from the table given in the last paragraph, Indian soils may contain considerably more. Only in the coffee-soils, Nos VIII—X, do we find what may be termed a deficiency. 11 Potash in Indian soils

In many parts of India, and notably in Behar, nitre (nitrate of potash) is found impregnating the earth, especially on spots where halutions have stood before. The earth is lixiviated with water and the nitre is extracted in an impure state, after which it is purified by boiling down the solution and crystallising out the nitre. Nitre

67. Soda, when potash is also present, can hardly be regarded as an essential constituent of plant life, and in India there is no lack of it. Indeed, the existence of soda salts in large quantity in the soil of some parts of India gives rise to an exceptional feature in the agriculture of the country. The selective power of plants for food is well known, and their preference for potash containing rather than for soda-containing salts has been well established. But in some parts of India, soda salts are present in the soil to such quantity as to positively destroy vegetation. The salts are brought up from the subsoil by the combined action of water and the sun's heat, and then crystallise out on the surface, forming a kind of "snow" which is termed "*reh*,"* and the land thus affected is known as "*utar*"* land. The composition of *reh* is not uniform, most generally carbonate of soda is the prevailing ingredient, at other times sulphate of soda, but both occur together, and associated with them in more or less quantity are common salt and salts of magnesia and lime. Of the origin of these salts there is no positive certainty, but they are most probably the salts which are dissolved out on the gradual decomposition of igneous rocks, and are subsequently deposited when the water which holds them in solution evaporates. That they may be afterwards brought to the surface, depends on two conditions being present— 12 Soda in Indian soils

* See for notes page 57

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Indian soils I quote the determinations

TABLE VII — Phosphoric Acid and Potash in Indian Soils

	I	II	III	IV	V	VI	VII	VIII	IX	X
	Wheat soils from Green Punjab (S. A. Voelcker)			Cawnpore Farm Soil (S. A. Hall)	Cowpore Farm Soil (E. Kitch)	Soil from Allahabad (E. Kitch)	Soil from Allahabad from the Jumna, N. W. P. (S. A. Hall)	Coffee soils from Mysore (S. A. Voelcker)		
Soil (dried at 212° F.) contained —	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Phosphoric acid	17	21	19	61	10	08	11	13	15	10
Potash	30	74	31	38	1.53	50	29	25	10	10

Although variations are shown in these results as regards the phosphoric acid present, in no case are there the marked deficiencies frequently met with in England, and, taking the four first-named soils as representative of a great tract of wheat growing land, I should consider them especially well supplied with phosphate. This may possibly have some

* For full analyses see Appendix A

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The utilisation of bones as manure

On the other hand, the somewhat lower amount of phosphoric acid found in *the soil*, *may be* *greater* *of the* *extensively* *by the planters*, and are considered necessary. The benefit of their application may lie also in the fact that they supply lime and nitrogen as well as phosphoric acid.

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12 Soda in Indian soils

Behar and usar

first, water to percolate down to the subsoil and to re-dissolve the salts, secondly, a strong evaporative force, such as the sun's heat, to draw them up and then crystallise them out upon the surface. I am unable to say either what amount of salt is met with in any particular soil or what quantity is found in practice to be injurious, nor yet, again, whether the carbonate and the sulphate of soda are equally injurious in vegetation, for, strange as it may seem to English men of science, the whole of the enquiries that have been conducted in India on the *sal* question have been carried out without associating with them any agricultural or even general chemist. I have little hesitation in saying that, owing to this want, much information that might have been gained, and which would have aided the enquiry greatly, has been lost, and that speculation and guess work have been indulged in where it would have been possible, had an agricultural chemist been at work on the subject, to have obtained certain knowledge.

The question of how to deal with *usar* land, with a view to its reclamation, will be dealt with later on (*see* paragraph 73 of this chapter). It will suffice to say here that deficiency of soda is not met with in Indian soils so far as I know, but there are, on the contrary, many instances of its presence in excessive and injurious quantity.

Need of an
Agricultural
Chemist as
illustrated by
the *sal* enquiry

68 The improvement of the soil in respect of any deficiency in the constituents named in paragraphs 58—67, must be effected by manuring. The consideration of this subject, and of the means available in India, will come more appropriately under Chapter VII (Manure) than here. It is evident however, that the increase of the manure supply for the purpose of enriching the soil is an important factor in the improvement of Indian Agriculture. To anticipate my conclusions, I would say that here again, as with the supply of water to dry tracts the work will have to be initiated by Government, while for the purpose of knowing what supplies are available, and what remedies can be effected, there is need of careful and scientific inquiry.

The work must
be initiated by
Government.

The improve-
ment of soil by
making of land fit
for cultivation

69 I pass on now to the second of the two heads given in paragraph 48, under which agricultural improvement may take place, *viz.* the reclamation of land, or the rendering fit for cultivation land which is now considered unculturable. Under this head are reckoned ravine and similar waste land land infested with *kans* grass (*Saccharum spontaneum*) and other weeds, and, lastly, saline or *usar* land.

Reclamation of
ravine land

70 Reclamation of ravine land may take place in two different ways—either by covering it with trees, shrubs, and grass, or by making the land itself fit to bear crops. The consideration of the first part of this subject will come more appropriately in Chapter VIII (Wood), when dealing with the question of wood supply, but it may be incidentally remarked that the growth of trees and grass implies an improvement of the soil itself, in that it becomes enriched by the accumulation of vegetable matter or *humus* derived from the decaying of the

leaves that fall upon its surface, as also from the herbage that grows on it, and which gradually dies down. It is not often that land cut up by ravines can be levelled, and the whole area be thus turned into a cultivable space, but much can be done to localise the effects of the floods that wash down and sweep before them the fine topsoil. In many cases these floods can be prevented from spreading their destructive influence further, and from injuring the lands that lie beyond them. The work of actually levelling ravines is too great and too expensive a one to contemplate, save in exceptional circumstances. Here and there an individual proprietor, having a large holding and also capital, may do it, and Government may also initiate it as a means of protection, or as 'famine work,' but it cannot be looked upon as remunerative. Much, however, may be done by throwing embankments across the *nullahs* or channels made by ravine streams, and thus holding up the water and preventing the continual washing away of the surface soil. I give instances of what has been already done in this direction.

E bankment of ravine streams

Captain Chapman on his estate at Batu in Ondra has carried out embankment of land on a large scale. He has thrown masonry dams or *bunds* across 13 channels (*nullahs*) which had been cut by the rain water pouring down off the higher land and he now uses the reservoirs thus made by the collected water for irrigation purposes. Captain Chapman has also reclaimed some of the ravine land by terracing it.

Captain Chapman's work at Batu

At Raksha, near Jhansi (N W P) an experiment was begun in 1883 by the then Commissioner Mr G Ward to see whether the denudations of the hilly country around could be stopped by making embankments which would hold up the rush of water in the rainy season and prevent it from washing the topsoil away. It was thought that fertilising deposits of silt might be formed near the embankments and that as the water soaked into the ground, silt might be left which would be readily cultivable while if the water did not disappear it would serve for irrigation use. The silt is thin with rock underlying it and walls are very difficult to construct. There is evidence that in former days when the country around was richer the Natives used to throw up similar embankments, and that the large proprietors used to construct dams to hold up the water, but these have now been let fall into disrepair. Mr Ward in 1883 began to throw up a series of embankments or *bunds* of earth, and at present 30 such have been made. The slopes have been covered with grass and grass is covering the sides. As yet water has collected to be used for cultivation but the trees have grown on the *dab* grass (*Cynodon Dactylon*) having spread considerably. It is said that the Station of Jhansi is cooler since these works have been made.

Experiments at Jhansi

At Nawabganj near Cawnpore, I saw 220 *bighas* of land (1 *bigha* = $\frac{1}{4}$ acre) which six years ago was waste ravine land under the Court of Wards. An enterprising Native became proprietor of this area, levelled it and then let it out to cultivators. It is now rented at Rs 5 per acre.

Reclamation at Cawnpore

Again at Etawah (N W P), although the ravine land there is converted into a Fuel and Fodder Reserve yet where the ravines lead down to the river (the Jumna) cultivation is carried out on every bit of land that offers itself and crops are grown partly on the soil washed down from the higher ground partly on the silt washed up by the river. If in such

Reclamation at Etawah

paces the first rush of water that takes place during the rains were stopped by embankments, then the good soil might be collected instead of being washed away into the river, and not only would more soil be available for cultivation, but the water might be held up for irrigating the land. Ravines such as those at Biawah extend all along both banks of the Jumna and Ganges rivers.

Reclamation of
other waste land.

71. There may be other waste land besides *tsar* and ravine land which is capable of reclamation.

Lake land at
Batu

I saw with great interest at Batu (Ondb) the 7,000 *bighas* (*bigha* = $\frac{1}{4}$ acre) of land which Captain Chapman had, with extraordinary energy, reclaimed. Formerly it was one vast lake into which the Ganges, when in flood, poured each year. What Captain Chapman did was, to shut out the Ganges entirely by constructing a massive embankment or *band* 7 miles long, and he then proceeded to pump the water back into the river. This work, begun in 1873-4, is now nearly complete, and what before was a lake is now cultivable land thrown into the property. With the help of steam ploughs and pumping engines the land has been tilled, drained, and also irrigated, and the soil, being naturally very rich, can grow splendid crops without any manure.

Reclamation of
land from the
sea.

At Mahim Toba (Bombay) a good deal of land near the sea has been reclaimed by embanking it so as to keep out the sea.

"Choh" land in
the Punjab

The enormous stretches of "choh" land in the Punjab, notably near Hoshiarpur, present a serious problem in the way of reclamation. Streams come rushing down from the hills, bringing at first silt, but sooner or later sand. At first the action may be beneficial, as the good soil from villages higher up is washed down, but soon the sand comes, and this is driven about with the wind and the good soil is covered and rendered unculturable. The land thus destroyed is called "choh" land. Some 30,000 acres of good land have been spoilt in this way, and remedies have in vain been suggested. The cause assigned is, that the hill sides have been over-grazed, and the trees along the banks of the former streams have been cut away, so that the soil is not held up, and the streams, no longer confined to their course, have spread over the country. The apparently most reasonable suggestion made is to close the hill wastes to grazing, and to let the sides clothe themselves again with grass shrubs and trees. There are, however, difficulties in the way of dealing with the "chohs" under Chapter III of the Indian Forest Act, the Government not caring to risk the responsibility of having to acquire the land (as they might be called on to do) some 10 or 12 years hence at fabulous prices.

Land infested
with *kans* grass
and *kunda*.

72. The infestation of land with *kans* grass (*Saccharum spontaneum*), with *kunda* (*Saccharum ciliare*), and other deep-rooted and fast-spreading weeds, is a matter for which there are remedies in deep and continuous cultivation and stirring of the soil, also by heavy manuring, and by leaving the weeds to rot, as well as by embanking and flooding the land with water. But, unless these steps be taken in hand early, the evil may rapidly increase, and the land be pronounced unculturable. Mr. Gollan, the Superintendent of the Saharanpur Botanical Gardens, pointed out to me the grass in the Municipal Gardens, Saharanpur, it is now a mass of *dab* grass (*Cynodon Dactylon*), but had at first been infested with *kans*. By manuring the land heavily with night-soil and town refuse the *kans* grass had disappeared entirely. Mr. Gollan believes that this can be effected in a single season, and he instanced to me that the same thing had been done at Wingfield Park, Lucknow.

I have myself seen, in the Central Provinces, land that was within quite recent times under cultivation, but which has

been abandoned on account of the *kans* grass. I learnt that the rent had been remitted on this account, but I could not help thinking that had the *raiyats* been obliged to cultivate their fields diligently, as they would have been, for example, in the congested districts of the North-West Provinces, the *kans* grass would soon have been eradicated. A North-West *raiyat* would have quickly been down on hands and knees and never have let the weed get the mastery. Here, on the contrary, amid easier surroundings, not only was the cultivation less careful, but as each field was in turn abandoned the weed spread, and its seed was carried on to the neighbouring plots, while the tenant who should have eradicated it at the beginning, rejoiced in the remittance of his rent. It may seem a hard thing to say, but I fully think that, in cases such as this, the improvement of the soil will be mainly effected by the pressure of circumstances necessitating a better and more careful cultivation.

In the Madras Presidency I saw a quantity of land near Bellary infested with the weed *kunda* (*Saccharum ciliare*), as also near Gadag, and along the Kistna river. The cultivators dig up the weed by hand labour, collect it in heaps and burn it.

73 Of a different nature to the foregoing is the improvement of saline land or *usar*, a subject on which much good work, energy, and ability have been expended by the Government, and mainly by the Agricultural and the Irrigation Departments of the North-West Provinces. Reclamation of
usar land
(usar)

Usar land, as explained in paragraph 67, is land which is impregnated with soda salts to such an extent as to make it unfit for growing crops. A white "snow," which is made up of these soda salts and is termed *reh*, spreads over the surface of the ground, and cultivation is impossible. Enormous areas, especially in the plains of Northern India are thus affected and in the North-West Provinces alone there are between four and five thousand square miles of *usar* land. In the Deccan and in the Southern Mahratta country, too, are similar large tracts. A strange feature is, that, scattered amidst the barren parts are patches here and there where cultivation, and that, too, of a high order, is carried on. Such crops as opium, sugar cane, wheat, castor oil plant, and cotton, all of which require a good soil and high cultivation, may be seen on these fertile spots, standing out like oases in the salt-covered desert all around them. How this has come about, whence the salts are derived, whether they are spreading in extent or not, how they may be checked, and how the land may be reclaimed, are questions which have led to many long enquiries and experiments to which I must here refer. Already in 1874 the Irrigation Department of the North-West Provinces set about trying to reclaim *usar*, and in 1877 a "Reli" Committee was appointed to investigate the subject, and to determine the basis of future enquiry. Subsequently, experiments were commenced at Awa in 1879, at Cawnpore in 1882, and at Aligarh in 1885. Most of these being still in progress, I was enabled to visit them and see what had been done. Extent of *usar*
plains in the
N W P

The Sah
Comm. ltee
1877

The origin of
reh

74. Naturally, the first question for the "Reh" Committee was, to say what *reh* was, and whence it came. Its composition, as explained in paragraph 67, is variable, but soda salts are always the main ingredients, the carbonate of soda preponderating generally, at other times the sulphate of soda, common salt and salts of magnesia and lime occur likewise. What accounts for the preponderance of one salt or the other on any particular area has not yet been shown. Different views have been propounded as to how the soda salts originated.

Professor
Medlicott's
views

Professor Medlicott, who was a member of the "Reh" Committee, held that *reh* was the result of the decomposition, by air and water, of rock minerals found in the soil, and that they were those parts unassimilated by vegetation, and which were not removed by rain water. He was, further, of opinion that the upper layers of the soil were originally quite free from salt, but that consequent upon the destruction of forests and the extreme climatic conditions that followed, aided by the introduction of canal irrigation, the salt was first dissolved and then brought to the surface. Professor Medlicott, relying upon one or two analyses made at his instigation, regarded the canals themselves as bringing a considerable amount of salt, and expressed himself strongly to the effect that where canal irrigation came, there must, in a few generations, be complete destruction by *reh*. In his view, *reh*, accordingly, was saline subsoil water.

Sir Edward
Buck's views

Other opinions found expression in the "Reh" Committee, Sir Edward Buck attributing the appearance of *reh* to the presence of a series of depressions, the salt from the higher parts getting washed into the depressions by the first shower of rain, thus the higher portions might become cultivable, and the depressions infertile, owing to the *reh*.

Opinions of the
"Reh"
Committee

Finally, the Committee came to the general conclusions that *reh* was the result of evaporation in a dry climate, that it would make its appearance if the water-level were raised, that it spread to a limited extent by surface washing, that its occurrence was concurrent with that of an impermeable surface, and that canal water did not itself bring the salt to the land.

Review of the
evidence; my
own conclusions

Reviewing the facts brought out, it appears to me that there is not sufficient evidence for believing that the canal water actually brings the salt to the land. The analytical evidence on which the assertion is based is neither strong nor consistent; the amount of solid residue per gallon in some of the analyses of water quoted is about 28 grains, a by no means large amount, while in others it is given as only 11 or 12 grains per gallon. Analyses made by myself of canal water from the Cawnpore branch of the Ganges Canal gave only 15 grains per gallon of solid residue, containing less than $2\frac{1}{2}$ grains of soda salts, while that of water from an adjoining well showed 72 grains per gallon of solid residue and 40 grains of soda salts. One would expect the well water to cause an efflorescence of soda salts rather than the canal water, but this was not the case.

Again, if canal water were the real source, it would not, to my mind, explain the fact that the composition of *reh* varies so much,

soil, but collected probably in depressions below the surface, and left as a deposit, just in the same way as a bed of phosphate of lime or similar mineral deposit is formed, or as a bed of sand, of gravel, or of clay, is found. So long as the surface was covered with trees and vegetation there would be less capillary attraction, but with the denudation that ensued would come the "baking" of the surface, where this surface was clay, capillary action would be much increased. Without moisture, however, the salts might remain harmlessly below, but if we now imagine canal irrigation to be introduced, there would be present the two forces requisite to bring the *reh* to the surface, *viz*, the water to dissolve the salt, and to draw the salt-holding clay by the capillarity of the clay account for what has been often

observed, *viz.*, that *reh* occurs in impermeable clay soils, and but very seldom on sandy soils. I incline, therefore, to the belief that where, amidst *usar*, culturable spots are found, it is either because these are spots where there is no *reh* underlying, or because, on account of the occurrence of a sandy rather than a clayey topsoil, capillary action is not so strong at that particular place. The same result of redologic capillarity would be effected by cultivation, by manuring, or by the growth of trees, shrubs, or grass. The fact that such measures as the above have proved the best in the endeavour to reclaim *usar* land gives considerable reason for believing that their removal has conduced to its existence.

The variability, not alone of composition, but of the extent of the action of *reh*, is another reason for considering its occurrence as *local*, and not as coincident with the distribution of canal water. There is what is called "very bad" *usar*, there is also other which, though salty, may be fairly easily reclaimed, and these are often found in close proximity to one another. How could this be unless the deposits were *local*, *i.e.*, unless there were more salt in some spots than in others? Nor would it be consistent altogether with a theory that attributes its occurrence solely to the incoming of the canal water. Canal water, I have no doubt, supplies one factor necessary to bring *reh* from below to the surface, but I do not at all think that it directly brings the *reh*.

75. Passing next to the experiments made for the purpose of reclaiming *usar*, I must briefly note these.

Experiments of reclamation of *usar*

The Irrigation Department areas in the Aligarh and three areas treated as plant holes, 4 feet deep, filling :

At Chherat there are 242 acres. One-half is left to itself, like Juhl, and the other half is sown with grass. The grass is the same as the grass sown at Juhl.

It is not known whether the grass is sown in the same way as at Juhl, or whether it is sown in a different way.

more particularly that there were numerous anthills inside the enclosure, but none outside. On these hills were gathered the glumes of the grasses, doubtless adding more vegetable matter to the soil, as well as loosening it. On comparison of notes that had been taken, these ant-hills were found to have moved

from their original position to new positions. This is a very interesting fact, and it is one which has not been noticed before.

further harm. However this may be, I believe that it is from these raised mounds that the soil is being improved.

It is not known whether the grass is sown in the same way as at Juhl, or whether it is sown in a different way.

in the hope of extracting the salt from the soil. But one bait of Chherat has been more recently worked on the lines of Amramau, and different methods of reclamation have been tried. Thus, 35 acres, on which the salt was two to three inches thick, were surrounded with an embankment, and the rain water was

held up by the embankment, and the water was allowed to soak into the soil. This method has been tried at Chherat, and it has been found that it is very effective.

It is not known whether the grass is sown in the same way as at Juhl, or whether it is sown in a different way.

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Another plan of reclamation tried has been that of manuring heavily with night-soil.

At Narainpur, near Cawnpore, Mr Muhammad Hissain took up 10 acres of *usar* land four years ago, and trenched night-soil in it before the rains. Mounds were put round and the rain water held up. After ten months the land was let to a cultivator for Rs 20, and Rs 40 was offered if a lease for six years were granted. Here canal water was available. Of this land there were 800 acres in the neighbourhood.

At Narainpur by use of night soil

6. At Dera Ismail Khan with a slight

Again at Dera Ismail Khan it was found that the "Ottley" plan (digging out the soil to a depth of about 18 inches spreading night soil in the pit 9 inches thick then sifting the earth back and levelling the whole, subsequently watering it) got rid of the *kalar* or saline efflorescence

Lastly, I have to instance other attempts to deal with *usar* land by growing trees upon it. In the cases given so far the success has not been a marked one, though it has been shown that they will grow, as also grass in abundance, if enclosure be resorted to

7. At Kapurthala (y or w) ing dist t es

In the Kapurthala State there are 9000 acres of land in Phagwara tahsil

she is I think be more extensively grown on *usar* land and there seems to be no reason why the Kapurthala plan should not succeed elsewhere

Summary of
experimental
work on *usar*
reclamation and
improvement
conclusively

76 To summarise the experimental work done on the reclamation of *usar*. It seems thoroughly established, Firstly that by simple enclosure and exclusion of grazing, grass (probably *usar* grass only at first) will establish itself, and cover even the worst places, that the grasses will slowly improve, and trees may be fairly successful. Secondly, that by covering *usar* land with a thick coating of canal silt, and then flooding it (as is done in Egypt), it may also be reclaimed. Thirdly, that by enclosure, feeding off the grass, embanking the land, allowing the rain water to be held up on it, then ploughing and manuring it, it can be rendered cultivable. Fourthly, that the same may be done by heavy manuring with night soil where water is procurable. There are difficulties to be encountered in every case, such as that of disposing of the grass grown, then canal water and canal silt are not everywhere available, nor is there sufficient night soil or other manure to warrant the outlay involved in reclaiming. But it seems to me that the plan of embankment and holding the water up, as well as manuring the land with stock put on it, is feasible everywhere. Where silt-laden canals are at hand, they could be run on to the land, for they would be in a silt-laden condition just at the time of the rains, when they are not so much needed for the irrigation of cultivated land. As to the grass difficulty, this might be overcome by making the grass into silage. The difficulty with hay making is that the grasses that grow often come during the rainy season, when they cannot always be made into hay, but if made into silage, simply stored in pits dug in the ground, they ought to afford abundant succulent fodder for cattle. Lastly, where trees are grown, the best plan is to have a rapid succession of quickly growing trees or scrub, rather than to try and obtain trees of any good size, the *dhal* (*Butea frondosa*), as at Kapurthala, should also be much more extensively tried.

Suggestions have been made in the past that subsoil drains

age will be found the only way to cure *usar*, but I can hardly look upon this as a practicable remedy in India.

Taking what I have seen, both of the occurrence of *usar* laid and the attempts made to reclaim it, I believe it to be concurrent with the existence of an impermeable condition of the soil, conducing (as clay does) to increased capillary action, and that improvement of such soil will be effected by any means which tend to alter this impermeable condition, either by forming a fresh and lighter surface, such as is done by the finely divided cal silt, or by breaking it up, as is done by the growth of grass or trees, or by mowing and ploughing. The formation of vegetable matter on the surface is, I believe, most important, and the covering of the soil with grass tends to decrease that "taking" of it which, as we have seen, is one of the most powerful agencies at work in causing *usar* to appear.

A good deal has been said, notably by Mr. Holderness, the Director of Agriculture for the North-West Provinces and Oudh, as to the result of the experiments not having been a financial success on the whole. To my mind a great deal too much has been made of this aspect, not that it is not the ultimate test of success, but because it should be remembered that until the effort has emerged from the experimental stage it cannot be fairly put upon its trial. So long as experiments are being tried, expenditure is made upon a great many things which have to be abandoned later on, experiment should be for the purpose of seeing *which one* of a number of different plans that have suggested themselves seems to give the *best prospect* of success, but not until this has been reached can the system itself be fairly said to be on its trial. It is a remarkably promising omen that Mr. Hensin has been able to show, even in the initial stage, such success as has been attained at Amramau, and to him very great credit is due.

Not long ago it would have been said the *usar* could not be reclaimed at all and to show that it can be is in itself, a most valuable fact. That it may not at present pay to take up *usar* land and so reclaim it, is a matter affected by present conditions, but there may come, ere long, a demand on the soil, owing to pressure of population and spread of cultivation, which may call for even *usar* land to be taken up, and then it may pay well to reclaim it. The experience gathered from past experiments will then supply the necessary guide, and a financial success may well result.

77 The reclamation of land whether it be ravine land or *usar* land, must as indicated in the foregoing pages, come mainly from Government agency. In a few instances the Native proprietors may follow an example set but the initiative must come from Government, and from Agricultural Departments in particular. The improvement of land infested with *kank* grass and other weeds is part of a better and more careful cultivation.

78 In reference to the reclamation of *usar* I have my surprise at this enquiry having been carried out without

Reclamation of
usar land and
the means of
Government

help of an Agricultural Chemist. Such a man would have been able to render very considerable help, and to have prevented many mistakes and speculations from being made. To take a single instance—when remedial measures were attempted it should certainly have been ascertained (as could have been done readily by chemical analysis) what amount of salt was present originally in the soil, and how much salt each remedial process had succeeded, in the end, in removing. It is still unknown in what quantity the salt exists, and in what amount it will be injurious. Such an example as this constitutes a strong claim for having agricultural investigation in India carried out with the association of an Agricultural Chemist. I do not say that the presence of such a man would, of itself, enable the *real* question to be solved, but I am sure it would very greatly aid the enquiry, and no such enquiry should be carried out without the assistance of an Agricultural Chemist.

CONCLUSIONS

CONCLUSION*

79. The differences which are directly traceable to the varying nature of soil are, like those resulting from climate, not capable of elimination either by the people or by the Government, they can only be modified to a certain extent. Any improvement of agriculture in this connection will be achieved by—

- (1) increasing, in dry tracts, the supply of water and, consequently, of moisture to the soil,
- (2) increasing the manure supply and enriching the poorer soil,
- (3) experimental enquiry and the scientific study of soils and their treatment

The main work of the above must fall upon Government, for the people will only in a few cases, at best, follow the initiative set, nor indeed will they have the means for so doing. The third part, or the introduction of Western Science, must also come from Government alone. Of scientific study of soils in India there has been almost a total absence in the past, and experimental work, as in the reclamation of *usar*, has suffered in consequence. I regard the problem of the possible exhaustion of the soil, under a continuation of the present system of agriculture, as one which the Government will have to meet by devising measures for increasing the manure supply of the country. Good work has been done by the Agricultural and Irrigation Departments of the North West Provinces in the endeavour to utilise ravine land and to reclaim *usar* land, and encouragement should be given to the continuance of this work of enquiry.

RECOMMENDATIONS

RECOMMENDATIONS.

80. I recommend —

The increase, by means of Irrigation, of the water supply to dry tracts.

The increase of the manure supply to the soil

The instituting of Enquiry to ascertain where such measures are needed and can be carried out

The continuation of Experimental Research, aided by Natural Science.

CHAPTER VI.

CHAPTER VI.

WATER

WATER.

81. WATER, in one form or another, is indispensable to agriculture, and in no country does this relation acquire greater significance than in India. So varied, however, are the climatic conditions met with in different parts, that each must be considered by itself before any general conclusion can be arrived at as to the sufficiency of the rainfall or the need of supplementing it. Not only climatic but geological features also will determine the need and the mode of further supply. This supplementing of the natural rainfall may, broadly, be called Irrigation. In this sense we may consider India as divided into three great areas:—

1st. Where irrigation is *not needed*.

2nd. Where irrigation is *highly desirable*.

3rd. Where irrigation is *absolutely necessary*.

82. The *first* division comprises districts where there is an abundant rainfall, these are protected thereby from drought and famine; such regions exist over Burmah, Assam, Eastern Bengal, along the sub-Himalayan range, and in the Western Ghâts. In the Central Provinces also, and over a great part of Central India, a sufficiency of rainfall is aided by the presence of a black soil which retains that water firmly, and to which the supply of irrigation would possibly be even harmful.

The *third* division comprises the driest tracts of all the regions of lowest rainfall, such as the arid plains of parts of the Punjab and Rájputana, with nearly the whole of Sind. In these, while irrigation is an absolute necessity for the carrying on of agriculture yet in respect of being subject to famine they are safer than those of the *second* division, this latter including all those districts where the rainfall is uncertain and variable. The reason of this, as explained in Chapter IV, paragraph 34, is, that where rainfall is low the *rasyat* or cultivator will never try to grow a crop unless he has a certainty of water, whereas, in parts to which sometimes rain comes in sufficiency and sometimes not, he is tempted to risk the growing of a crop, and should the rain then fail, the crop may be entirely lost. It is these districts of uncertain rainfall that are the really "precarious" ones, and here the fear of famine is almost ever present. They are the tracts which are *precipitously* extend over a great Deccan, and Madras. In these precarious tracts that Government have devoted such constant efforts, and that so much skill has been exercised by the Irrigation Department is particular.

General division of India in reference to irrigation requirements.

Division into "protected" and "precarious" tracts

Precautions Districts indicated on Rain-fall Map

83. It is well now to summarise the main types of water supply met with in India, and, after that, to show how irrigation differs in character and how its extension is largely dependent upon the physical conditions and geological features of the country.

- (a) In the first place is the *Rainfall*, abundant reference has been already made to this in Chapter IV (Climate). The dark-coloured parts on the Rainfall Map are those of heavy rain, and are thus naturally protected from drought. Under the same heading has been mentioned the water retaining black cotton-land, where, too, irrigation is not called for. This soil covers the parts coloured green on the Geological Map.

The above districts may be considered as "protected," and as not requiring farther irrigation.

- (b) After this we may take those districts which do not require irrigation, because they are inundated by rivers, or which, though not inundated, yet derive sufficient moisture from rivers in their proximity. Instances of the latter have been given in the tracts along river beds in the Punjab. Inundated tracts are found also in many parts of the Punjab, for instance, at Multan, where the country beside the river banks is often flooded to the extent of six or eight miles. Again, in Gújrat (Punjab) and other tracts along the foot of the hills there are large areas which are annually inundated by mountain streams bringing silt down with them. The rainfall is insufficient for the crops, and the spring level is too deep for irrigation wells, so the flood waters of the torrents that issue from the hills are turned out of the beds of the torrents by means of temporary dams erected in the beds, and are thus poured on to the slope of the country. The latter thus acquires sufficient moisture and also a renewal of silt more than equivalent to a manuring. An instance of a dry tract such as this is Shahpur, between the Indus and the Jhelum.

- (c) Next are the canals:—

These may be classed under three heads — (1) The *perennial canals from snow-fed rivers*, found, for instance, in Northern India. (2) *Inundation canals*, available only while the river is in flood. The banks of the river are above the level of the surrounding country and the flood waters are carried off from the river. This is, accordingly, a rainy season supply only. Such canals are met with in the Southern Punjab and in Sind. (3) *Canals or other channels from rivers that are not snow-fed*. A dam, or "ancut" as it is technically known, is thrown across the bed of a river, and the latter is turned into a lake, from which it is led into canals and distributing channels. In this way

(c) Canals and river channels

autumn and winter supply is obtained. Of this nature are the channels off the Canveri, the Godavari, and the Kistna rivers, in Madras.

- (d) Wells
- (d) The next system is that of wells, the most widely-distributed one, but seen principally in the alluvial belt of the Ganges plain, and notably in the Doab (or two-river district, i.e., the country lying between the two rivers, the Ganges and the Jumna).
- (e) "Tanks"
- (e) Then follow the so-called "*Tanks*," principally found in Madras, where the ground is rocky and the country hilly or undulating. These are really lakes or reservoirs, and are constructed by putting dams across depressions or valleys. In them rain water is collected for use in the dry season. Some are also fed by jungle streams and rivers as well as by rain water. They occur, further, in Rājputana and in Central India.
- (f) Shallow
lakes or ponds.
- (f) Lastly come the *shallow tanks or ponds* which are dug in the earth whenever the soil is of a clayey character, and serve to hold the one year's supply of rain water. These ponds are met with in Western Bengal, the valley of the Ganges, as also in Madras.

Distribution of
systems of irri-
gation according
to the physical
features of the
country
Geological Map.

84. On referring to the Geological Map, sufficient reason will be found for the occurrence of the particular systems in each part, the alluvial soil of the north (coloured *brown* on the map) lending itself rather to canals, wells, and shallow ponds, and the rocky ground of Madras (coloured *red* on the map) to the so-called "tanks," as well as to channels, whilst the central, or black cotton-soil portion (the part coloured *green*) needs neither particularly. But the

down for wells, and this part, including the Punjab generally, is essentially the region for *canals*; the central part, the North-West Provinces, is the *well* district *par excellence*, though supplemented here and there by canals, then, coming to Bengal,—in the tanks, and mainly where clay to be retained, whilst in the enough, and canals would be out of place and even do harm. In Madras the underlying rock,

and can be easily obtained from shallow wells of, say, 10—20 feet depth. This is the case, for instance, at Bareilly. Next may be

one where the water lies deeper and is less readily obtainable, and canals may be called for in addition. Such is found to be the case in the Doab, where wells are 20—30 feet deep. Lastly, may come a region situated on a central elevated ridge of the country where the wells are too deep to be profitably worked; the water is often brackish, and canals are the only available means of irrigation. This is the case along the Jumna river, the wells being 30 feet deep or more, and the water bad.

I have set these points out, because without bearing them in mind it is not possible to understand the considerations that have to be taken into account in providing for the irrigation of any tract, nor yet to grasp the point of what I wish particularly to impress, *viz*, the necessity of careful enquiry into the agricultural requirements of each separate district and the best way of supplying these.

85. Before dealing with particular points connected with each class of irrigation, in The great work done by the
 may possibly be effect man-
 make, by saying, at work,
ion of
country,
 both for protective purposes and for the improvement of its agriculture, shows how deeply concerned they are in the well-being of the people.

For the Government Departments, be they
 to mistakes
 where harm
 rather than good has resulted, I prefer, and think it is but right, to acknowledge the vast work done and the enormous benefit that has accrued to the country generally as the result of the attention which Government have bestowed on this great subject of Irrigation. It is hardly necessary even to ask that the operations should be extended, for both Government and the Irrigation Department are fully alive to the necessities, and will not fail to avail themselves of every opportunity for extension of their work.

86. *Perennial Canals.*—It has been explained that in certain parts, for instance, the Western Punjab, the rainfall is very meagre, and the water-level is so low that wells cannot be sunk profitably; hence the canals from snow-fed rivers are the only means of irrigation. I cannot give a better instance of the change effected by the introduction of a canal to a dry, arid tract, than what I saw in the course of my tour through the country lying around Multan in the Punjab. The Sidhnai Canal has been brought here, and now, wherever it spreads its arms, fertility and Perennial Canals.
Changes produced in the appearance of the

Beneficial effects
of canals

(The S. Indus
Canal)

occurs, or where water has lodged in a depression, that there is any cultivation at all, but where the water can reach, agriculture flourishes. On one side of the railway line, as I travelled from Multan to Rasbide, the Sidhnai Canal spread, and cultivation was all around, on the other side of the line there was no canal, and the land was entirely bare, save for a few stunted bushes. No one could see the contrast presented, without being deeply impressed by the great good done by canal irrigation. This scheme was started in order to take settlers from the congested districts of the Punjab (Lahore, Amritsar, etc.) It was estimated that 64,000 acres of land would be required, but already 110,000 acres have been let to cultivators, so that the canal has been very successful. Other instances which particularly struck my attention, as exemplifying the beneficial effects of canals upon agriculture, were the remarkable development of market-gardening around Amritsar (Punjab), the outcome of the Bari Doab canal, the sugar-cane and rice cultivation at Hospet (Madras), which has entirely developed since a channel was taken off from the River Tungabhadra, and the sugar-cane cultivation around Poone.

Primary use of
canals

When speaking of wells I shall have occasion to point out respects in which I consider that cultivation by means of them is superior to cultivation by canal, but it is necessary to point out that it is only in a very limited region, mainly the Doab, that the two systems really come into competition. What is requisite in extending canals is, to take them primarily to those districts which have no other available means of water supply, but not to supplant an existing cultivation carried on by means of wells or tanks. But where these latter means are insufficient, then canals may do a great work in supplementing the supply. The main object should, however, be to carry canals to the parts where agriculture must depend upon them alone.

Objections
urged against
canals

87. It has been urged against canals, and with some reason, that in some cases they have been brought where they were never needed, that they have been carried across the main drainage lines of the country, and have obstructed the natural drainage, besides raising the water-level, causing the spread of the saline efflorescence known as *sal*, spoiling the wells, and bringing fever and ill health to the population affected. There have been, and always will be, minor complaints of the occasional harshness of higher, and the corruption of inferior, canal officers. But, to my mind, all these objections sink into insignificance before the grand work that has been done, and that is now being carried on in the light of the experience of the past. Were but the cultivators to use the water with anything like the care with which it

tion and of distribution—but they are now careful to avoid these as far as possible, and when extension of canals is made, it is only after the agricultural circumstances and needs of the districts have been considered, in order to determine whether they ought

to be served by canals or by wells, and in order to construct the canals so as to give distribution of water over the widest area possible

88. I will now consider the several objections taken to canals. The first is, that canals have been carried where there was no need of them. A colour is given to this objection because, in order to reach tracts where there is no other means of water supply, canals have sometimes to pass through districts already provided for; still, it is quite true that canals have been brought unnecessarily to some parts of the country. In the Cawnpore district of the North-West Provinces there are many villages along the line of the canal, like Rura, which ought to have depended upon wells, and, indeed, were partly supplied with them, but now only the ruined remains of the wells are left, and had no masonry when the water-level canal. That this is I made special enquiry. destruction of wells undoubtedly occurred at first, yet the water-level soon became constant, and wells can now be easily made without masonry. What really happened was, that when the canal came the cultivators relied entirely on it as the easiest means of watering their fields, and so they used the water wastefully, and allowed the wells to fall into disrepair. It is only when the supply of water runs short, owing to the spread of irrigation over a wider area, that the *raiya*t begins to get economical in the use of canal water. In some instances, indeed, the canals have improved the wells by raising the water-level and making the supply more accessible. Still, there is undoubtedly some reason for complaint that canals have been carried where they were not required. An instance of this is seen in Orissa, where a canal was started in 1866 as a protective measure, after the famine that occurred there, but it has never been wanted since, and has not only been unremunerative, but has also done positive harm to the country by interrupting the natural drainage. The upper part of the Western Jumna Canal is, similarly, not a success. Both in Behar and in the Bombay Presidency there are canals which, in so far as they have not paid directly for their construction, have been called "failures." But this is not a fair view of looking at the question, and no one who has had experience of the loss of human life and of cattle in past times of scarcity, and will contrast it with the protection afforded by the canals now, can for a moment doubt the wisdom of constructing these very canals, although the expenditure may not have been directly repaid. Nevertheless, in districts where wells can quite readily be dug, their extension rather than the replacement of them by canals should be sought. In the Cawnpore district I have seen the wealthier cultivators constructing masonry wells, although they had the canal flowing past their land. They were, however, situated near the termination of the canal, and knew that the supply of water was precarious because of so much being used higher up the stream. But

Canals have been taken where not required.

Instances.

on their wells they could always rely, and so they preferred to dig them rather than to trust to the canal.

Construction of
reservoirs at
termination of
canals

89. In district situated near the termination of a canal, and where consequently the supply of water must be uncertain, it is worth considering whether reservoirs might not be advantageously constructed which would serve as storage tanks for irrigation purposes. At Cawnpore, during the hot season, I saw the crops of some Kāchhi cultivators which were being quite ruined owing to want of water, for, although the canal was within a stone's throw and water was passing down it, there was not sufficient water to allow of the outlet to the cultivators' fields being opened; nevertheless, the stream, then flowing two feet deep, shortly afterwards found its way again into the river, and its benefit was lost to the land. Had there been a reservoir at the end of the canal, or some system of small tanks in the fields themselves, which could be filled and drawn from as required, less entire dependence could have been placed upon the uncertain canal supply.

Canals have
interfered with
the natural
drainage, and
caused ill health
to population

90 The second objection urged against canals is, that they have interfered with the natural drainage of the country, and that by raising the water-level, they have brought fever and ill-health to the people. This, again, is a charge which has much to support it, but the Irrigation Department is fully alive to the necessity of avoiding these evils in the future, accordingly, new canals are now aligned with greater care. Villages in the Etah and Cawnpore districts of the North-West Provinces, others in the Delhi and Kernal districts, as also some along the Bari-Doab Canal in the Punjab, are known to have suffered from excessive canal irrigation, and to have become unhealthy on account of the faulty construction of canals, and a reduction of assessment has, in consequence, had to be granted. This subject opens up a very serious problem for consideration. Are the people to have the land left dry, and the climate healthy, though they themselves may suffer and die from the inroads of famine, or are they to reap an abundant harvest at the sacrifice of health? In other words, are they to drop off one by one by slow degrees and unnoticed, or are they to be swept away in numbers at a time by famine? This is, to put it plainly, the position that has to be faced. The verdict, it seems to me, must be the one that actuated the appointment of a Famine Commission, and also their subsequent recommendation that, the preservation of the lives of the people being the chief concern, the causes which stand out most markedly as sweeping the population away wholesale must be first combated. Beyond

The problem of
canal irrigation

Small drainage
as a remedy

the exercise
of introduction
drainage is,
India, and for
the purpose of merely reclaiming *salty land* (usar) is hardly to be thought of, but where the lives of the people are concerned, and when there is undoubted evidence of the depopulation of waterlogged districts, I do not see how the issue can be long delayed. At all events, I think that subsoil drainage should be thoroughly

put to the trial, in order to ascertain whether it can be carried out successfully on a large scale

91 Other objections to canal irrigation follow as consequences of the two main ones already noticed. It has been mentioned that the introduction of canals has been detrimental to existing wells. But it is urged also against them that they have caused the spread of the salty efflorescence termed *reh* (see paragraphs 67 and 74), in districts watered by canals. I endeavoured in the last chapter (paragraph 74) to explain the part which canals play in the production of *reh*, and to show that they supply the water necessary to dissolve the salts that lie below the surface and enable them to be brought to the surface by capillary attraction. I have pointed out, however, that, by flooding the affected land with silt laden canal water, a remedy can be provided, and the injured land be practically reclaimed by means of the canal.

Other objection against canals

Spread of *reh*, etc

92 *Perennial and Inundation Canals* — The water serves rather as a substitute for rain than as a fertiliser. In the case of the Inundation Canals, on the other hand, the silt-laden waters of the rivers are carried at flood time to the higher lands, and thus afford greater benefit to districts where rainfall is deficient. As their name indicates, Inundation Canals are of use only in the rainy season, and they are taken off from rivers the banks of which are above the level of the surrounding country. Such canals are met with principally in the Punjab and in Sind. This system was in vogue before the time of the English occupation of India, and many of the canals were constructed and worked by the Natives themselves.

the Inundation canals and the

93. *Canals or River Channels from Spring-fed Rivers* — These occur principally in Southern India, and do not differ except in their origin and methods of construction and distribution from the aforementioned snow-fed canals. It has been often pointed out that a great deal of water is allowed to flow down the rivers of Southern India and to find its way into the sea, whereas increased means of intercepting it before it reached the sea would result in a large amount of water being saved for irrigation purposes. Mr Nicholson, in his "Manual of Coimbatore," points out that much good might be done by storing the water of great rivers in reservoirs, and that it would not only supply irrigation, but would prevent a source of danger to the districts below, which arises from the sudden rushing down of the river at the beginning of flood time. In a Report on the Condition of Anantapur Mr Nicholson instances that the water of the Pennér and the Ilagari rivers might be advantageously stored in this way, especially as the districts through which these rivers flow are peculiarly exposed to drought.

River-channels from spring-fed rivers

Possibility of storing water from rivers before flowing into sea.

94. *Tanks* — This term, as applied to the rain, stream, and river-fed reservoirs which occur principally in Mndras and in Central India, is an incorrect one. They are in reality Lakes or Rese

"Tanks"

Waste of water in
rice cultivation

formed by the erection of dams across depressions or valleys, and are fed either by the rainfall or by jungle streams and rivers. They are largely utilised in Madras for rice cultivation, and it is certain that a very excessive quantity of water is often used from them. I noticed this particularly at Salem. Mr. Nicholson reckoned that in Coimbatore as much as 12 feet depth of water in a season was used from tanks kept for rice cultivation. Frequently the tanks are the property of individuals or communities, and are managed by them. In some cases, however, the Irrigation Department undertakes the distribution of the water. Better management in the repair of tanks is a matter calling for attention, and will be referred to later. The supply of water from tanks which are merely rain-fed must, at best, be looked on as precarious, owing to the uncertainty of the rainfall. Tank irrigation is, however, preferred to any other for rice cultivation, but a cultivator will not begin to use a tank unless he knows that there is sufficient water in it to last him for his crop throughout its whole growth. If the tank be full, he grows rice, if it is not, he grows other crops. The consequence of waiting is that a good deal of water is wasted by percolation, and the tank may, after all, not be available. It is difficult to suggest any remedy.

Cultivation by
tank irrigation.

Though tanks occur mostly in Southern India, yet they are sometimes made in the rice-growing districts of Bengal; or else reservoirs are formed by throwing embankments across drainage hollows or natural slopes of fields, and are used for irrigating rice in the event of long droughts; when required, the banks are cut and the water is allowed to flow out. Reports from Chotan Nagpur show that while in some parts, Polamau, for instance, irrigation by these reservoirs is a necessity for rice, in others, such as Lohardaga, only a few tanks exist. More might, however, be easily made and the rice be irrigated. On occasions when drought has occurred, the villages that possessed embanked reservoirs have suffered no loss of rice; once at Banda, for example, the banks were cut, the water was led for four miles, and over 200 acres of rice were thus saved. Even in the Central Provinces it is now under consideration whether in parts, such as the Mandla and Balaghat districts, tanks should not be constructed for rice irrigation.

Shallow tanks
or ponds.

95. *Shallow Tanks or Ponds.*—These are the true Tanks, for they are excavated reservoirs, and are not merely those formed by embanking depressions or valleys, thereby holding up the water that comes. The true tanks only hold the rainfall of the year, and dry up entirely in the hot weather. Where the soil is
 onstruc-
 ter will
 rain-fed,
 and the

Wells

96. *Wells.*—I have left the consideration of wells until now, so that I may include under this head some of the principal differences that occur between cultivation by wells and that under other

means of irrigation. Irrigation by wells is not once the most widely-distributed system, and also the one productive of the finest examples of careful cultivation. I may fairly say that nothing in the agriculture of India impressed me so much as the excellence of the cultivation carried on by irrigation from wells ("garden" land). This was not the case merely in one or two parts only, but in almost every instance where this system of cultivation was adopted.

Excellence of
"garden"
cultivation

Whether it be in the *betel* and plantain gardens of Mahim (Bombay), the market gardening of Meerut (North-West Provinces), the "garden" land of Coimbatore, in Madras, or that of Gujrat and Hoshiarpur in the Punjab, the finest cultivation I have seen has almost invariably been that carried on by well irrigation. Here it is that the greatest care is given, and the greatest economy used, it is for this land that manure is most saved, and from it every weed is plucked away as an intruder, here every inch is utilised for growing crops—not one crop alone, but often three or even four together—and to these crops the precious water is dealt out, as it were, by measure. To take a single instance—at Mahim the *betel* plant is watered every sixth day until manure is applied to it, and after that every third day until the rains come, sugar-cane once every six days until the rains, plantains similarly, and ginger at intervals of three days only. The explanation of the excellence of cultivation as carried on by irrigation from wells is found chiefly in the fact that every drop of water has to be raised by the *rasyat's* labour and that of his bullocks, and that the well itself has often been built with his own money and by his own hands. But I must not dwell on this except to say in regard to this cultivation that I can suggest nothing in it to improve, indeed, the people have mastered thoroughly all details of the system. English farmers may well join with me and look on in admiration, and it should be the aim of every one interested in agricultural improvement in India to extend this method of irrigation in every way possible.

Little or nothing
to improve in
this respect

Further, as regards wells, one cannot help being struck by the skill with which a supply of water is first found by the native cultivator, then by the construction of the wells, the kinds of wells and their suitability to the surroundings and means of the people, also by the various devices for raising water, each of which has a distinct reason for its adoption. All these are most interesting points with which I am not called on to deal, for I see little to improve in them which the cultivator does not know perfectly well. I would, however, draw attention to Major Clibborn's valuable Report on the Construction of Wells in the North-West Provinces, where many particulars as to wells and well irrigation can be found.

Ingenuous de-
vices of the
native culti-
vators for rais-
ing water

97. As I have explained before, it is only exceptionally that cultivation by means of wells can be brought into comparison with that by canal irrigation, and it must be remembered that the value of the latter system consists in the fact that canals can often be brought where construction of wells is impossible.

Comparison
of cultivation by
well or canal.

the two systems exist near one another I have sometimes had the opportunity of comparing them. Such was the case at Amritsar, Cawnpore, and elsewhere, frequently, too, wells are used, as at Multan, to supplement the canal supply and to ensure the safety of the crops. Not only are the plots on well (or "garden") land kept very much freer from weeds, but infinitely more care is taken with the distribution of well water than of canal water, except, possibly, when the latter has to be raised by lift from the canal before it can be put on to the land. When canal water is available the tendency is great to let the water flow on just as one would turn on a tap and allow it to run. No extra labour is involved, and no extra charge is made for the quantity of water used, as the water rate is solely for the area brought to maturity. But in the case of a well, all water raised has labour expended on it, and so the cultivator is careful that it is only used on the area he has paid for. It is made to go as far as possible. In the case of two systems of irrigation, the water is divided in two ways. In the first, the water is divided by means of small embankments which direct the flow of water to particular parts, are numerous and small in the case of cultivation by wells, in canal cultivation, on the other hand, they are few and large. Colonel Forbes, the head of the Irrigation Department, pointed out to me that for every bed which exists in the case of canal cultivation there would be from five to eight beds on the same area if a well were used.

Loss by percola-
tion in water-
courses

Irrigation
Department
might have
further powers
over water-
courses

Major Chibborn, in his Report, remarks on the loss sustained through percolation in watercourses, especially in the case of long canal channels, and in village watercourses. Well watercourses, on the other hand, are short and are well made as compared with those of a canal. The canal courses in villages are the property of the cultivators, and are made by them, but, as the villagers have no interest in the economy of canal water, the courses are often badly kept, and the loss by percolation is very great. Advance in this direction might be effected if the Irrigation Department had more powers of construction and of improvement of watercourses, and if they could recover the cost by a small rate. It is very difficult for an isolated cultivator to arrange for the water to run to his field when it first passes through his neighbours' fields. The main courses, which are kept up by Government, are, as a rule, in excellent order, and the loss by evaporation and percolation is comparatively small.

Waste of water
in low
irrigation

Although there is a rule to enforce the making of beds or compartments of a certain size, the *rayats* who use the canal water will evade the rule if they can, and the canal officers find it difficult and harassing to enforce it stringently. In districts to which canals have recently come, the people are new to this particular mode of irrigation, and this fact affords another reason for the authorities not wishing in press too much at first for compliance. As a consequence, water, when distributed from a well, is generally put on to just a sufficient depth and no more,

but canal water is often run on to an unnecessary extent. Major Clibborn concluded from his investigations that rather more than three times as much water is used for irrigating an acre from a canal as from a well. The average depths of water used were 0.9 inches from wells and 2.56 inches from canals. This has led to a consideration whether, in future, canal water should not be supplied by "lift" only, instead of by "flow", but it is felt that the plan would not work, inasmuch as a cultivator will often wait until the last moment, in the hope that rain may come and so enable him to dispense altogether with the canal water, or rather, with having to pay the rate for it. Thus, very frequently, he will not take the canal water until positively obliged to do so. Had he then to raise all the water by "lift," he would not be able to get enough labour to irrigate the whole area in the time, and the canal would fail in accomplishing its object.

Should all canal water be raised by lift?

Similarly, all attempts at devising a scheme for payment of water by the quantity used have failed.

Failure of attempts to fix payment of water rate by quantity used.

At Multan, Ferozepore, and Shiyali, I observed instances of beds or compartments being made too large, at Hospet, on the contrary, far more care was exercised, and the compartments were not much larger than in "garden" land.

In the Punjab it is found, as the result of increasing canal irrigation, that the tendency is to grow more wheat. This is the case whenever the canal runs long enough to supply moisture for sowing the crop, inasmuch as a single fall of rain afterwards, about January, suffices for wheat.

A disadvantage in cultivation by canals as compared with that by wells is that in the latter case a man has always some work to do, and is more independent than if he relies on a canal which may only be let on to his land at intervals. Hence when there is the chance of giving the land a good soaking the tendency is to put a great deal more water on it than is really necessary.

Again, a *raiyat* is not so careful in levelling his field when he uses canal water as when he has to raise water from a well, and thus waste is incurred with canal water.

98 This leads me to the consideration of the "overcropping of the land, consequent on the introduction of canal irrigation. The Report of the Famine Commission records instances where deterioration of soil has followed the coming of canals into districts previously unsupplied by them. Undoubtedly, with the introduction of a canal into a district comes also the tendency to force the land to bear more crops than it ought to, unless it be plentifully supplied with manure, which is seldom the case, also, the careless use of the water causes the washing-out of those constituents of the soil which should form part of the crops. Moisture and heat are necessary to bring the soil constituents into activity, but over-watering not only produces a state of stagnation and coldness but goes farther, and actually removes the very plant food which it has been instrumental in bringing into an assimilable condition.

Over-cropping of land consequent on canal irrigation

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Irrigation
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Waste of water
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irrigation

Although there is a rule to enforce the making of beds or compartments of a certain size, the *rayats* who use the canal water will evade the rule if they can, and the canal officers find it difficult and harassing to enforce it stringently. In districts to which canals have recently come, the people are new to this particular mode of irrigation, and this fact affords another reason for the authorities not wishing to press too much at first for compliance. As a consequence, water, when distributed from a well, is generally put on to just a sufficient depth and no more,

but canal water is often run on to an unnecessary extent. Major Chibhorn concluded from his investigations that rather more than three times as much water is used for irrigating an acre from a canal as from a well. The average depths of water used were 0.9 inches from wells and 2.6 inches from canals. This has led to a consideration whether, in future, canal water should not be supplied by "lift" only, instead of by "flow"; but it is felt that the plan would not work, so much as a cultivator will often wait until the last moment, in the hope that rain may come and so enable him to dispense altogether with the canal water, or rather, with having to pay the rate for it. Thus, very frequently, he will not take the canal water until positively obliged to do so. Had he then to raise all the water by "lift," he would not be able to get enough labour to irrigate the whole area in the time, and the canal would fail in accomplishing its object.

Should a canal be run on by "lift" only?

Similarly, all attempts at devising a scheme for payment of water by the quantity used have failed.

Failure of attempts to fix payment of water rate by quantity used.

At Multan, Ferozepore, and Shikohi, I observed instances of beds or compartments being made too large; at Hospet, on the contrary, far more care was exercised, and the compartments were not much larger than in "garden" land.

In the Punjab it is found, as the result of increasing canal irrigation, that the tendency is to grow more wheat. This is the case whenever the canal runs long enough to supply moisture for sowing the crop, inasmuch as a single fall of rain afterwards, about January, suffices for wheat.

A disadvantage in cultivation by canals as compared with that by wells is that in the latter case a man has always some work to do, and is more independent than if he relies on a canal which may only be let on to his land at intervals. Hence when there is the chance of giving the land a good soaking the tendency is to put a great deal more water on it than is really necessary.

Again, a *rasyal* is not so careful in levelling his field when he uses canal water as when he has to raise water from a well, and thus waste is incurred with canal water.

98 This leads me to the consideration of the "overcropping" of the land, consequent on the introduction of canal irrigation. The Report of the Famine Commission records instances where deterioration of soil has followed the coming of canals into districts previously unsupplied by them. Undoubtedly, with the introduction of a canal into a district comes also the tendency to force the land to bear more crops than it ought to, unless it be plentifully supplied with manure, which is seldom the case; also, the careless use of the water causes the washing-out of those constituents of the soil which should form part of the crops. Moisture and heat are necessary to bring the soil constituents into activity, but over-watering not only produces a state of stagnation and coldness, but goes farther, and actually removes the very plant food which it has been instrumental in bringing into an available condition.

Overcropping of land consequent on introduction of canal irrigation.

Depends upon
the kind of
water used.

It is necessary to make the reservation here, that much depends on the kind of water employed. If it be what may be termed a "poor" water, that is, one without any silt, or with but little mineral salts in it, the effect will be a "washing-out" one, not if silt be brought with the water, or if it contain fertilising salts, the result may be a "renewing" one. It is often the case that canal banks are cut, and that the water is let on the land for the sake of the silt, the principle of this waste of water being that the more water that is used the more silt is there deposited. Thus, the Tanjore Delta, which is all rich rice land, has been formed entirely by silt brought down from the river Coleroon, a branch of the Cauveri.

Preference of
cultivator for
well water

99. Where both canal and well water are available the preference of the *raiyat* is very marked for the latter, more especially for his "garden" crops. He calls the canal water "cold," the well water "warm," and when the well water is brackish (*khara*) it has in his eyes particular virtues for certain crops, especially tobacco, which the "sweet" (*meetha*) canal water does not possess. As to one being "warm" and the other "cold," there is a certain amount of truth in this, for irrigation is employed mainly in the cold season, when the canal water is the colder of the two, besides this, the canal water often comes over clean river beds, straight away from the melting snows, whilst the well water is below and is impregnated with the earth's salts. The chief reason, however, is, I believe, that over-watering with canal water brings about a cold and stagnant state of the soil, such as happens with an imperfectly drained clay soil in England, and causes a "chilling" which the well water, since used in lesser quantity, does not produce. In reading papers which have been written on this subject I have been amused to notice the speculations indulged in on this point, whereas in none of the investigations has a single record been given of the actual temperature of either the canal or the well water. The speculations as to the particular salts contained in either well or canal water are equally random. For example, one writer speaks of "compounds of ammonia and lime," these being, as yet, unknown to science, another is not afraid to say, "the superiority of cultivation by wells I attribute without hesitation to the presence of lime," and thus without any analytical data whatever to support the assertion. These points I name as showing the desirability of associating in any future investigation a scientific man with knowledge of chemistry. It is only fair, however, to Sir Edward Buck to say that he did take the precaution to have an analysis of the water made when he was investigating this question of relative efficiency.

Speculations as
to the difference
between canal
and well water

Need of a
chemist.

My analyses of
canal and well
waters.

I was led to examine this question myself, so far as occasion permitted, and, in April 1880, I was conducted by Mr. Holder-ness, the Director of Agriculture in the North-West Provinces and Oudh, to a village named Rawatpur, not far from the Cawnpore Experimental Farm. Here a well was shown to me which was considered to yield water especially good for the tobacco

crop, and to be much superior to the water from the canal (Cawnpore branch of the Lower Ganges Canal) which flowed near by. I took samples of the well water, and Mr. Holderness subsequently collected others from the canal supply. These I sent to my laboratory in London for analysis.*

The composition of the two waters may be represented as follows, the quantities being stated in grains per gallon:—

	Canal Water	Well Water
	Grains per Gallon	Grains per Gallon
Sulphate of Lime	1.60	10.71
Phosphate of Lime	13	1.50
Carbonate of Lime	4.65	4.00
Carbonate of Magnesia	3.52	13.23
Chloride of Potassium . . . . .	.03	.50
Carbonate of Potash . . . . .	.60	—
Chloride of Sodium	—	14.00
Nitrate of Soda	—	8.00
Carbonate of Soda	2.30	16.41
Oxide of Iron and Alumina . . . . .	.23	—
Soluble Silica	1.26	1.06
TOTAL Solid Residue per Gallon	15.10	71.23
Free Ammonia . . . . .	.001	.002
Albuminoid Ammonia . . . . .	.007	.005

* For full analyses see Appendix C

From these figures it will be seen how very marked is the difference in the amounts of solid constituents contained in the respective waters, the canal water having only 15 grains to the gallon, as against 72 grains in the well water. Lime does not constitute a leading distinction, altogether there are 3.96 grains of lime in the canal water and 7.56 grains in the well water. The divergence in magnesia is much more marked. It is mainly, however, in the soda salts present that the waters differ, and in the nitrates, chlorides, and sulphates. The canal water contains 1.40 grains of soda, but the well water has no less than 20.53 grains per gallon.

Chloride of sodium (common salt), nitrate of soda, and carbonate of soda, with carbonate of magnesia and sulphate of lime, constitute the special properties of the well water. It is further noticeable that the well water does not contain more, but rather less, potash than the canal water, and that it is as salts of soda, and not of potash, that the greater part of the salt exists in the former. This I was hardly prepared to find, fully expecting that nitre (nitrate of potash) would be present to a large extent.

Repeated applications of the well water would, accordingly, be equivalent to a manuring with readily soluble salts such as

nitrate of soda, carbonate of soda, common salt, and salts of magnesia. To this is, no doubt, due the believed fertilising quality of the well water; in other words, it is owing to the large amount of salts held in solution.

Incidentally, it may be mentioned that, as regards organic matter, but little ammonia, though it is as the well water has

Need of further
chemical study.

This is but one analysis of well water, but, from my observations, I am sure that the composition of the water varies very greatly in different parts. In some cases the salts, instead of being beneficial, are considered hurtful to crops. A chemical study of this subject would lead to interesting and useful information, and give definite knowledge instead of the present uncertainty that exists.

Analyses by
Mr Venis

I have found a record of two analyses of Ganges river water, taken at Benares, by Mr G. Venis, which show the total solids contained in the waters to be 16.52 and 19.95 grains per gallon respectively. These figures do not differ widely from my own. The dates of Mr. Venis's samples were December 19th 1888 and February 6th 1889.

Removal of
superfluous
water

100 Having spoken of the means of supplying water, it is well to mention also means of removing water, or rather, of preventing the harmful effects of a rapid flow of water. Some of these have been instanced already. Thus, improvement of land cut up by ravines has been spoken of in Chapter V, paragraph 70, subsoil drainage and damming up of rivers, in paragraphs 90 and 93 of the present chapter. A further plan is that of embanking arable land, in order to stop the rapid flow of water over its surface at the beginning of the rainy season. It is in the Central Provinces, perhaps, that this has been most effectually tried, for it has been found that by embanking fields the rich topsoil is not washed away, and a quantity of water is also held up, which comes in usefully for irrigation later on. Great encouragement has of recent years been given to the spread of this practice, more especially by the issue of vernacular notices to the effect that such improvements will be exempted from assessment at the next Settlement. The Administration Report of the Central Provinces for 1883-89 says, on page 8—

Embankment or
bunding of land.

Much done in
Central Pro-
vinces.

Encouragement
given to practice
of bunding

"The failure of rain in October 1888 showed the advantage of embanking land, the bunded fields retaining moisture enough for sowing, whilst the open land was hard and dry."

In some parts of the Central Provinces it is found that by holding up the rain water a crop of wheat can be taken after the rice crop is off. Irrigation has even been proposed for wheat itself, but it would be washed away to a considerable extent. It is well to point out that it is not so much the total quantity of rain that falls

but the amount that falls at one time, that may do harm to the land.

It is possible that a good deal of existing swampy land might be reclaimed by draining the water off, but this could hardly be carried out unless a Government grant for drainage purposes were made. Draining of swampy land.

101. I might now indicate, by way of instances, some districts which came under my notice, and which stand in need of further irrigation. In the Punjab, Multan and Hissar are two places where a quantity of land could be brought under cultivation if canals were more extended. The success of the Sidhnai Canal has been mentioned, but there is also a great unwatered tract enclosed between the rivers Chenab, Ravi, and Sutlej. The land here is rich, all it wants is water. At Hissar, too, the canal supply is very uncertain. Districts in need of further irrigation. The Punjab

In the North-West Provinces, Mirzapore is badly off for irrigation, there is none from canals, and but little from wells. Agra, Gwalior, and Jhansi are all precarious tracts. The first named is on the edge of the "shrinkage" of the monsoon; i.e., the monsoon rains may stop short before reaching them. Gwalior is likewise badly placed, the wells are 60 feet deep or more, and the district is too far off for irrigation to be satisfactorily brought to it. At Jhansi, wells are over 40 feet deep; bunding, as stated, is being tried here. There is also scope for extension of well digging near Cawnpore. North West Provinces

In regard to Bengal, mention has been made of the good that would follow the making of irrigation reservoirs in Lohardaga (Chota Nagpur), and Mr Basu mentions tracts in the valley of the Amanat and the plain of the river Son where irrigation canals and reservoirs could easily be made. Bengal

In Rājputana, Ajmere is known as a precarious district which the monsoon frequently does not reach. Parts of the Deccan, again, stand much in need of irrigation, whilst, coming down to Madras, we find numerous other instances. Anantapur is one of the driest districts in the Presidency, being badly situated for both the south-west and the north-east monsoons, there are only about 37 wet days in the year, and, with an annual rainfall of only 28 inches the water soon dries up. Tanks are, therefore, very uncertain. Bellary, Kurnool, Coimbatore, and Madura are also very precarious districts. At Bellary the wells have to be made in the solid rock, and are 45 feet down, there are no canals, and but few tanks. Kurnool has few wells, the supply of water is poor, and the water itself often brackish. Coimbatore, being situated on high ground, has no irrigation except from wells, and they have to be taken about 45 feet down, and through rock. At Madura there is great want of water, and all the tanks have been made that can be made, both canals and wells are, accordingly, wanted here. The possibility of extending wells in the Madras Presidency is shown by the fact that during the recent distress, in the Chingleput district alone the Government have advanced 2½ lakhs (say Rājputana. Deccan Madras

2,000/), to enable 10,000 more wells to be begun. Mr Nicholson has pointed out, also, that the waters of the Pennér and Hagari rivers might usefully be stored for irrigation purposes, also that a storage scheme for Kallapuram, whereby 2,000 acres might be irrigated, is quite feasible. The centre of Mysore is another part which is very poorly off for water, and wells might, with great advantage, be constructed. The possible advantage of tanks in certain districts of the Central Provinces has been indicated, as also the benefits that would follow the embanking or bunding of and The Sangor district is a case in point.

Mysore

Central Provinces

Interdependence of water and manure

102. There is a matter which I do not wish to pass over, but the full consideration of which I postpone to the next chapter, I mean, the interdependence of water and manure. The one without the other is productive of but limited good, and in most cases, it may be said that either of them alone is useless. An estimate given by Sir Edward Buck, in reference to land near Ajmere, expresses this point as follows—"Irrigation from tanks is lavish, and it is put on to lands which it has robbed of its fertility, as the manure supply, before deficient, is now totally insufficient to restore fertility. Given unlimited manure, water will raise the rental of land to Rs. 50 an acre, with no manure it will sink to 1 rupee an acre."

Agency by which improvement of agriculture by better supply of irrigation may be effected

103. We must now consider how the extension of the different systems of irrigation, according as they are best suited to each case, may be carried out.

Minor works may be done by the people themselves aided by Government

Major works must be constructed by Government

Where minor works have to be constructed, such as the digging of wells of a moderate depth, the making of shallow tanks, and the embanking of land, these may be entrusted to the people themselves, aided by a judicious system of "advances" of Government money for the purpose of beginning such works. To this system of advances the name "*taccavi*" is given.* In a later paragraph I will endeavour to show what improvements in the working of this system may be effected. But for all works of greater magnitude, such as the carrying of canals over the country, the taking off channels from rivers, the formation of large reservoirs or tanks, dependence can alone be placed on Government. It is true that in former times the people themselves made inundation canals, and constructed large reservoirs which are still objects of admiration, but the people are not so likely now to construct fresh ones, but rather to rely on the Government, besides this, whatever may be said of the excellence of the earlier constructions, the engineering skill of the Irrigation Department is now able to carry out more effective and lasting work. It is to assist the people in works which they can carry out themselves, and to do what they cannot do, that the efforts of

* *Taccavi* system—a system by which advances of money at a low rate of interest are given by Government to cultivators for agricultural improvements, and mainly for the digging of wells. The rate of interest charged is 1 pie per rupee per month, or 6½ per cent per annum.

Government should be put forward. The initiative must now rest more than ever with Government, and, as I have pointed out, a careful enquiry is necessary in the case of each separate district, so as to ascertain exactly what its irrigation requirements are, and how best they may be met. It should be a main duty of Agricultural Departments to set on foot such enquiry.

The duty of
Agricultural
Departments

104. The last paragraph leaves still open for further consideration the agency by which wells of more than ordinary depth, or those which have to be made under circumstances of special difficulty, are to be constructed. To give instances:—

The making of
wells in rocky
land.

Instances.

In the Coimbatore district of Madras the wells are frequently in rock, and are large and costly, the depth varying from 15 feet to 40 feet, while they have to be wide also, in order to include a spring within the area. At Bellary, similarly, I noticed that wells had to be cut through rock to a considerable depth, and had also to be made very large. Mr. Nicholson, in his "Manual of Coimbatore," speaks of wells as "being the mainstay of revenue and the *raiyat*" and he says:—"Unless by great irrigation schemes or development of wells, it is not probable that production can keep pace with human reproduction." In another place he says:—"Well irrigation alone prevents minor famines," but he also instances frequent cases where "wells have been begun and given up" "because of the interposition of impenetrable rock." In my own enquiries in these parts I found that the cultivators often shrink from taking Government advances for digging wells, because of the chance of rock intervening, and the consequent difficulty of cutting through it; they might have to go to an uncertain depth, with the chance of not finding water soon enough to make the well profitable to work, and thus they might expend the whole advance and yet not obtain water.

The ignorance of the *raiyat* in the matter of "blasting" of rock is a further hindrance.

It is worthy of remark that in the last great Madras famine it was the deep wells that held out, so that a decided advantage follows their construction in precarious districts, an advantage which must be looked on in the light of a "protective" measure, and not as distinctly remunerative. It appears to me, therefore, that in cases of difficulty, where, on account of deficient rainfall and absence of canals, the agriculture absolutely depends upon wells, it is fully worth considering whether Government might not undertake the construction of wells. In other cases, however, it is probably better that the cultivator should be encouraged to construct wells himself; he chooses his own spot (and no engineer could do it better), and he employs his own labour and materials. Wells could undoubtedly be constructed more cheaply with the landlord's materials than with those which the Government would have to obtain and bring to the spot.

Construction of
wells by Gov-
ernment.

It is only in exceptional cases, therefore, that I consider the construction of wells by the State is desirable. But it would

be easy, in many cases, to make the system of Government advances more known and more popular, and to induce the cultivators to avail themselves further of its advantages.

Major Clibborn, in the report already referred to, in paragraph 97, concluded that, as regards the North-West Provinces, a rate of Rs. 2 per acre of annual irrigation would cover the outlay of construction of wells. The cost would, of course, vary in different parts according to the depth and nature of the soil passed through. But it must be remembered that Major Clibborn was dealing with alluvial soil and not with hard rock, such as is met with in Madras. He reported that Government could not safely undertake the construction of wells on a large scale, but that they must leave this to the landlords (*zamindars*), and to the working of the *taccari* system. (See footnote on page 80.)

Proposed scheme
in Madras

Since my return from India I have heard from my friend, Mr. R. H. Elliot, of a scheme which he has laid before the Government of Madras for the digging of wells by Government in unoccupied fields, and the loaning them out to cultivators at "wet" rates of assessment. In Madras, it must be explained, the waste land belongs to the State, and it is not an uncommon practice for a *raiyat*, after cultivating a field for some time, to throw it up and to take another, the field so thrown up remaining in the hands of Government until a fresh tenant is found. In this way enormous quantities of land may be in the hands of the State at one time. Mr. Elliot now suggests that if the Government were to dig wells in these unoccupied fields, or perhaps even on waste lands, and thus gradually turn them from "dry" to "wet" lands, not only would the country be protected against famine, but the revenue might, in the end, be very greatly enhanced. Such a project is one which would carry with it great benefits, though it is obviously only where a land system similar to that of Madras prevails that it could be adopted.

Much can be
done if
Government
are prepared to
regard works as
productive measures

There is no doubt that a great deal can be done in improving the water supply in precarious districts, if Government are prepared to look on the measures taken as those of a "protective" and not purely a remunerative nature. This is well expressed in a note by Colonel Mead, Chief Engineer for Irrigation, Madras. He said in 1887 —

"Much can, no doubt, be done to improve the existing supply to tanks 'if Government are prepared to accept the benefit to the *raiyat* as a sufficient return for outlay incurred, and to consider the works as entirely 'protective in nature'."

*
Management of
small tanks by
the people

105 I found a very general expression of opinion, both in Madras and in Bombay, that the management of small tanks should be left in the hands of the village communities, or else be under the Collector of the district, and not be administered by the Irrigation Department. At Belgam there are a great many tanks, and these are managed by the villages, the water

being let out for a group of 100 fields at a time, the *raiyats* settling among themselves how it is to be used

On the other hand, the management of canal branches by the people has been tried and has not been found to be successful. Thus, the Eastern Jumna Main Canal was made by Government, but the branches by a joint-stock arrangement of the cultivators, the Government advancing money for the purpose. The cultivators, however, could adjust neither the sharing nor the payment among themselves, and Government had finally to take the management into their own hands. It has been found also in Southern India that there has been considerable neglect shown by the people in keeping irrigation channels in order. The people allow underwood to grow, and let the leaves fill up the channels and there decay, one place after the other becomes marlous and the people leave, going higher up the stream. So, too, in other parts weeds are allowed to overgrow tanks, and then the people go lower down, and leave the Government to clean out the tanks.

106 Improvement can certainly be effected in providing for the more prompt and better repair of tanks. Mr Nicholson, in his "Manual of Coimbatore," mentions the case of Kondampatti village, in Udumalpet, where the repair of a large tank is quite feasible. In Beogal, Burdwan is mentioned as a part where repair of tanks is difficult, and Palamau as a division where there are many reservoirs which are out of repair. Once when at Poona, I met a number of landowners and others interested in agriculture, and an unanimous opinion was expressed by them in favour of the management of small tanks by the communities themselves and not by Government, and especially that the repairing of these should be left to the village communities.

The same opinions were expressed to me on the occasion of a similar gathering at Madras. Going on from Madras to Madura, and then to Coimbatore, more precise particulars were given me, not by landholders, but by actual cultivators. In the Madura district, where there is much tank irrigation, there were complaints of the difficulty in getting repairs done and a desire was expressed that this work might be put under the Revenue Department rather than the Department of Public Works, the Collector being considered the person who knows the wants of the people best. The cultivators instanced the delay that takes place when a tank wants repair, how that when the *Tahsildar* hears of it he goes to the divisional officer (Assistant Collector), the latter to the Collector, the Collector to the Executive

requiring no special skill could be effected at once by the Collector's direction. It was, of course, necessary for large engineering works to be required in and to wait, but three quarters of the "major" work (anything over 200 acres of irrigation being considered "major" irrigation) was simple work of repair, putting up *bunds*, digging channels, digging tanks, etc., which any workman could do, and which needed no particular skill.

Class based on of tanks desirable.

It would appear desirable, from what I gathered, that there should be a classification of tanks, and, in accordance with this, it should be determined which tanks should be managed and repaired by Government, and which by the village communities. It is clear, anyhow, that good might be done by a simplification of the process by which repairs are effected. Necessarily there must be official enquiry as to any work of magnitude, but in nine cases out of ten the repairs required are those which call for immediate attention, and which, if neglected, may produce very much aggravated consequences. If the circumlocution that has been instanced could be avoided, and a certain amount of discretion and executive power be given to the Collector to have these repairs effected at the time, the local needs would be more readily met, and expense be, in the end, spared.

The system of factory advances

107 It remains for me to refer to the system of Government advances known under the name *taccari**. Though not confined to the purposes of digging and repair of wells, it is mostly for these that the advances are used, and they are the schemes which are the most satisfactory in their working. Advances are also given for embanking of land, for purchase of cattle, purchase of seed, and occasionally to assist in payment of debts. The advances are made by Government at a moderate rate of interest (6½ per cent per annum), and are intended to save the people from being compelled to resort to the money-lender or *banija* who charges a rate of 12, 18, or more per cent, and out of whose clutches the cultivators seldom get. The plan is an excellent one, but its success depends entirely upon how it is worked, and how nearly it is brought home to the people, and is adapted to their means. What is still requisite is, to make it clear to the cultivators that the system is one that will benefit them, one that will enable them to benefit themselves. If this idea could be once thoroughly grasped, the advantages, not alone to the people, but to the Government, in the form of an increased revenue from the land, would be very great.

The difference in the way in which it is administered in different districts.

Anyone going through the country as I did, could not fail to be impressed forcibly with the difference between the way in which the *taccari* system is worked in one part and that adopted in another, and also with the dependence of the system, for its success, upon the energy and interest of a single individual, this being, as a rule, the Collector or Deputy Commissioner. Whilst the system is popular in some districts—

* See footnote on page 80

for instance, in Belgaum (Bombay), the Native State of Kapurthala, Multan, and other parts of the Punjab—in others, such as Aligerh (North-West Provinces), it is reported that ‘the people will not have it on any terms,’ and in Madura, Coimbatore, and other parts of Madras the complaints are great as to the difficulties put in the way of making use of the advances for the digging or repair of tanks.

When advances are made by Government agency the returns show that it is but seldom that there are arrears of any long standing, and the State loses very little on this account. The objections of the people to avail themselves of the advances do not arise alone from difficulties put in the way, or because the advantages of the system have not been sufficiently impressed upon them, but largely, also, from their own fault, their careless and improvident habits, their suspicion, and their inability to appreciate what is intended for their benefit. The most important factor in removing these hindrances is the personal interest and activity of the Collector or Deputy Commissioner.

The cultivator will often prefer to resort to the money-lender, because the latter gives him the advance at once, because he asks no questions, and does not insist upon the money being devoted solely to the particular purpose for which it is given, he does not come round and see that the work is being carried out, but allows repayment at leisure, lastly, he has no intermediaries who require to be “feed.” When, however, a cultivator applies for a *taccari* advance, he complains (and frequently with reason) that the delays are long, and that the enquiries are put off, that he has often to wait several days at the *Tahsildar’s* office before that official will attend to him, and that, in the end, the advance frequently comes too late to be of any use, that he is bothered by minor officials who come to see that he has not used the advance for other purposes, by others, again, who come to “pase” the work, but who one and all require their “palms” to be “greased,” and that the money, thus filtering through several hands, never comes to him to the full extent of the advance, lastly, that the Government insist on punctual payment of interest and repayment of loan. Thus the *ratyat* comes to undervalue the advantages of the *taccari* system, and resorts to the easier method of going to the *baniya*, though it may be dearly bought in the end. Then, having once obtained the money, he will often use it for marriages and for other extravagancies rather than for the presumed object, and thus he gets involved deeper and deeper in debt.

The objections of cultivators to the *taccari* system

108. I will now give some instances of the need that exists for the cultivators to be made more acquainted with the advantages of the *taccari* system, and also of the need for better administration of the system

Scope for extended adoption of the *taccari* system

At Rera, near Cawnpore (North-West Provinces) I saw a cultivator who was constructing a masonry well at a cost of Rs. 100. This was intended

North West Provinces

to irrigate 25 acres. The cost was being paid partly out of the man's savings, partly by gifts from his family, and the remainder was borrowed from the money-lender. The man *knew nothing about Government advances*. Other cultivators here said the same thing.

Punjab

In the Punjab Administration Report for 1888-89 it is noted, in regard to the Gurgaon district: "*Tahsildars* need constant reminding of the desirability of encouraging advances. A lot has been done in Rewari, but there is no reason why the number of wells should not be doubled in the district, also well repairing should be done by *faccars*. The payments, when advances are made, are very punctual."

Bombay

At Ahmedabad (Bombay) I found that the *faccars* advances were not made use of. The *Mamlatdar* did not like the trouble attaching to them, his objection was, that he had to keep separate accounts for them.

Central Provinces

In the Central Provinces, at Saugar, only two wells have been dug by means of Government advances in the last three years. Of Dongasara it is reported: "There might be more wells here, and the *malguzars* (landlords) could easily make them." The Chief Commissioner (Mr Mackenzie), in his proceedings for the year 1888-89, points out that it is not the debt to the *bania* that ruins the *rayat*, but the high rate of interest and the way he is cheated in settling his accounts with the *bania*. Also he instances a case where in one division there was an extremely high mortality of cattle and where the people would surely have been glad had help been given them, and yet there was not a single loan for purchase of plough cattle, and this entirely because the Deputy Commissioner did not trouble about it.

"The fact is, that the granting of the treasury and *tahsil* Commissioner has made it that people are able to

When at Madras, I met in conference a number of landholders, they one and all spoke of the difficulties in the working of the *faccars* system, and at a similar conference at Poona it was remarked that local officers did not trouble about *faccars* because it entailed extra work on the *Mamlatdars*, *Tahsildars*, and others, and they had to keep separate accounts for it.

Madras

During my tour in the Madras Presidency I come across many instances of the non use of *faccars* advantages. At Salem I found that only four or five wells had been sunk in the last two years by Government aid. The people preferred to borrow locally at 12, 15, or even 18 per cent, and not to be restricted in their application of the money. At Avonashi (Coimbatore) *rayats* borrowed to ally at 13 per cent, in preference to using the Government loan. I was told that in Tinnevely the risk of taking the *faccars* advances was, that if a man took a loan and tried to dig a well, he had to pay whether he was successful or not and the rocky nature of the ground made the attempt very uncertain. In cases where a man has tried and failed, I think, possibly, the rules might with advantage be relaxed.

Bengal

In many parts of Bengal the landlords (*zamindars*) have no direct interest in the produce of the land so long as they get their rents, and they are often too encumbered to lay out capital in water supply, the *rayats* are too poor to do anything unaided, and, in consequence, reservoirs that use to benefit low lying rice fields have fallen out of repair, and no fresh ones have been constructed.

Instances of energetic administration of the *faccars* system

109. By way of contrast, I may now mention cases where manifest advantage has followed the energetic administration of the *faccars* system, and the popularising of its objects and advantages.

In the Punjab Administration Report for 1888-89 it is said 'The Punjab "increased resort to *taccari* is in many cases due to the personal influence of Deputy Commissioners." Again, "In the Montgomery district the "system of advances is undoubtedly popular"

In the Multan district I found that the Deputy Commissioner had, in the last year alone, given Rs 28,000 in *taccari* advances for the digging of wells to supplement the supply of water from the Sidhnai Canal

In Belgaum (Bombay), and entirely through the personal energy of the Collector and District Deputy Collector, advances to the extent of between thirty and forty thousand rupees annually have been made during the last four years, and the number of applications have averaged 748 per annum. Advances are made for well and tank digging and repair, for embanking, for removing rank grass and weeds, for levelling ground and making rice fields out of dry land, for purchase of seed and cattle, and for cutting away prickly pear. The District Deputy Collector (Honourable Gurbidapa Virbasapa) who was in charge of two divisions (*talukas*) seven years ago, took a personal interest in the matter, and by himself explaining to the people the advantages of the *taccari* system induced them to take it up. The Collector, Mr. Munr, issued circulars in the vernacular, and now all the seven *talukas* of the Belgaum district have adopted the system. During the seven years there has not been one bad debt, and so much work has been thrown on the *Mamlatdars* that three extra clerks have had to be obtained for this work, the cost being paid out of the *taccari* grant. The District Deputy Collector explained to me that everything depends on the prompt examination of applications, and on not keeping the applicants waiting about at the *Mamlatdars* office or sending them to and fro repeatedly. The only reason that advances were not even more used was, that the people had already mortgaged their lands so much for other debts that they had no security to give for the Government advance. He was of opinion that it was absolutely necessary for the people to be ready with their payments on the day fixed, and that it would not do to allow them any laxity. With this opinion I am inclined to agree, and, though at first I thought that where security was good some liberty might be shown, I now believe that strict enforcement of payment when due is advisable.

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Mr. Fuller reports, further, that very great progress has been lately made in the amount of the loans advanced under the Agriculturists' Loans Act (No XII of 1884). The figures for the last three years are as follows —

Year	Number of Loans	Amount
		Rs
1887-88 - - -	1,444	26,000
1888-89 - - -	1,692	45,285
1889-90 - - -	2,535	1,07,459

Such a marked increase is highly satisfactory, and shows what can be done by the exercise of personal energy. It is added that, "in the whole of the Central Provinces recoveries were made without difficulty; in only one case was resort to coercive measures found necessary; Government realised 64 per cent. on its outlay under the Agriculturists' Loans Act." Of Bilaspur, which has been mentioned in paragraph 108 as having been backward in utilising the advances, it is now said, "for several years it was reported that the people were reluctant to take advances, but in 1889-90 Rs 16,768 were advanced here alone."

The *taccas* system in Native States.

110 Native States have not been slow to realise the advantages of advances for agricultural improvements

Jeypore.

In Jeypore the cultivators are *not allowed* to borrow money for sinking wells, the State advances money at interest varying from 6 to 12 per cent, and the Land Revenue has increased very considerably wherever wells have been dug

Kaparthala

In the Kaparthala State under British administration, the system of giving advances for agricultural improvements has been made easy, and is largely used. Within the past two years Rs 63,482 have been distributed,

Advances for seed, wells under the *taccas* system of wells during the last 10 years had been made by means of *taccas* advances. Major Massy reports that repayments are generally made with punctuality,

Necessity for removal of obstacles and complaints of cultivators

111. The foregoing instances show clearly how much has been done, and also how much can still be done, if only the matter be made a *personal* one. Were further demonstration needed, it would be found in the case I have mentioned in paragraph 101, viz., that during the quite recent distress in Madras the Government advanced money to the extent of 20,000*l.* in the Chingleput district alone to enable 19,000 new wells to be begun. Besides this, nearly 10 *lakhs* (say 72,000*l.*) were advanced in the Kurnool, Bellary, Anantapur, and Cadapah districts for well digging, and 1½ *lakhs* (say 9,000*l.*) under the Agriculturists' Loans Act.

The want of capital on the part of the *raiyat* is undoubtedly a main source of the difficulty in enabling him to undertake

the construction of wells, tanks, etc., on his own account, and, therefore, the aid of Government may most advantageously be called in to assist him and to better the agriculture of the country. But it is incumbent that every reasonable difficulty that stands in the *raiyat's* way, and which prevents him from availing himself of the advantages, should be removed.

I do not say that the objections and complaints of the cultivators are valid ones in general, or that the indifference of the people is not mainly their own fault, but there are ways in which procedure may be simplified, and the system of advances be made more popular. And here, while suggesting some improvements, I would desire not to be misunderstood, nor to hint in any way that Government are not fully alive to the importance of urging on their district officers the carrying out of the system, nor, again, am I forgetful of the great good that has been done in the past. But the subject is one which cannot be forced too often or too strongly upon the notice of Government and its officials,

112 In the first place, the issue of vernacular notices, setting forth the advantages of *taccari* advances, should be more widely adopted, and these should be supplemented by the personal activity of the district officer. In certain cases, as has already been done in some parts, there might be added special inducements to the taking up of the advances, such as the securing of exemption of improvements from assessment at the time of the next Settlement. I am quite aware that the Government have declared in India generally that they will not tax improvements effected by private capital, including those made by means of *taccari* advances, but, as a matter of fact, this promise is rendered nugatory in many parts, inasmuch as taxation is raised, not on account of the improvements directly, but on the general grounds of rise of prices, construction of new roads, extension of railways, and other means of communication, consequently, there is no certain security under the present system that private improvements will not be taxed. As long as this continues, it will certainly act as a bar to agricultural improvement, and will prevent the outlay of private capital on wells and minor works of irrigation. I think, therefore, that the system should be relaxed, at least to the extent of securing to the man who digs a masonry well that he shall not be directly or indirectly liable to any rise of taxation on account of the improvement which he has effected by the expenditure of his private capital upon it.

Ways in which the *taccari* system may be rendered more popular

The non taxation of improvements.

There is little doubt that had such a provision existed in reality as well as in name, a great many more irrigation works would have been carried out by private effort. A single instance will make this clear. In a Resolution of the Revenue Department of the North-West Provinces and Oudh, No 898A of 1889, a comparison is drawn between the four districts Gazipur, Jaunpur, Ballia and Bezwarr which are

under permanent settlement as regards the Land Tax, and the adjacent and similarly situated districts which are temporarily settled, and, consequently, are liable to periodical revision of the Land Tax. In the former, 55 per cent. of the cultivated area has been brought under irrigation by wells, tanks, and streams, and in Jannpur alone 55,224 wells have been dug by private capital. But in the temporarily settled districts only between 16 and 17 per cent. of the cultivated area has been brought under irrigation from wells and other sources, exclusive of canals. If the land under canals be added, there is, even then, only a total of 22 per cent. of the whole cultivated area of the temporarily settled districts under irrigation, as against 55 per cent. in the permanently settled districts, there being no canals at all in the latter. Private efforts, therefore, under these circumstances, have done far more than all the aid of Government, even including the making of canals. The points here brought out are well worthy of consideration, and it has further to be remembered that anything which induces the people to invest money on the land gives them a permanent interest in the continuance of the English rule.

Avoidance of delay in giving advances and in making repairs

Next, all hindrances to and delay in giving advances must be removed. The *Tahsildars* and others must know that it is not a matter of their choice whether or when they will attend to applications, but that it is their clear duty to expedite the advances. A fair interval must be allowed for an improvement to tell, before payment of instalments is called for. This done, I am in favour of strict adherence to the rules as to payment on the date when due, and I think that the rate of interest is well within the cultivator's means.

Again, repairs should be more promptly attended to, and minor repairs, as also the management of the smaller tanks, should be left to the village community themselves, or to the Collector's authority.

In certain cases, such as that instanced, where a man, after taking a *taccavi* advance for digging a well in rocky ground, has failed to reach water, the rule might be relaxed in his favour, if it be clear that he has spent the advance in the endeavour.

Transference of surplus from one district to another

113 An improvement might be effected in the method of disposing of surplus funds accruing from grants made for *taccavi* purposes.

When the *taccavi* grant for any district has not been fully applied for, so that a surplus is over, this surplus might well be transferred to another district where the applications may have exceeded the original grant made for the purpose.

Allocation of money to district officers which must be spent for advances

It is also worth the consideration of Local Governments whether a certain sum of money should not be given annually to each Collector or Assistant Collector, which he would be bound to expend in advances for wells or similar improvements. This would not leave it so much a matter of choice as it is at present with the

district officer whether he will exert himself or not in the giving of advances for agricultural improvement.

In the last place, I am strongly of opinion that some share in the administration of *taccari* advances should be put in the hands of the district officer. It is clearly better that the share in the administration of *taccari* advances should be in the hands of the district officer than that it should be in the hands of the Agricultural Department.

Advances could hardly be entrusted to the Provincial Directors of Agriculture. But, at the same time, the Director of Agriculture is the person who should best know the agricultural needs of his Province, and he should be enjoined to give his special attention to the extended working of the *taccari* system. Further, he should be empowered to advise the Revenue Authorities generally, and to report on specific cases, either of special need, or of non-observance in the application of the funds which have been granted.

It is a misfortune attending the position of the Director of Agriculture that he has no immediate executive power, but he should certainly, I think, be entrusted with the share in the administration of the *taccari* advances which I have indicated.

"or well manured land. In 1291, a year of drought, there was an opportunity "of making the contrast, the well-manured dry land in the most prominent "case belonging to a *Pariah*, and having an excellent *cholam* crop, while "surrounding fields had practically *nil*. The *raiyats* are perfectly aware of "the reason and allege want of capital and pasture

Proverbs current
among the
people

There are numerous proverbs current among the people as to the necessity and value of manure, but the practice is often not as good as the precept

Mr. Benson gives, along with others, these from Kurnool:—

"*Turra* (a kind of soil) hangers after manure as a Brahman after *ghis*, "a field without manure is as useless as a cow without her calf (meaning that she will not give milk unless the calf is before her).

Mr. Nicholson quotes these:—

"Old muck and lots of water," "turn dry land into wet, pen your cattle "(in the field), and feed straw to them," "muck is better even than the plough." "If manure is useless (good) soil is useless, or "manure is better "than good soil.

Interdepend-
ence of water
and manure

118 It has already been mentioned in the last chapter (paragraph 102) that water and manure are really interdependent, and that the supply of the one must be considered in reference to that of the other. In parts where rainfall is sufficient, manure alone may have to be sought, and where there is freshly-reclaimed or virgin soil, or land enriched by silt, the supply of water alone may suffice. But these conditions seldom prevail. In the course of my enquiries I found that in every part where rainfall was light, water and manure were mentioned together, and it may be said, without fear of contradiction, that one is necessary to the other, and that without the presence of both, the full benefit of neither will be obtained, in brief, they are interdependent. This is well set forth in the following extract from the Report of the Director of Land Records and Agriculture, Bombay Presidency, 1888-89:—

"It cannot be doubted that (1) character and distribution of rainfall, (2) "want of capital, and (3) want of manure are the most important factors "which regulate the demand for canal irrigation. "As "regards manure the difficulty is great. Irrigated crops trench on the "temporary fertility of the soil, which must be restored either by manure "or rest. Irrigation therefore cannot be carried beyond the limits which "the supply of available manure fixes."

A practical proof of the truth of the above is seen in the sugar-cane cultivation around Poona, the entire industry being the outcome of the joint supply of water and of manure, whereas neither, by itself, would have been sufficient. It was not until the canal was brought here that the sugar cane cultivation sprang up, and then the growers found that they must have manure as well. Meerut, Amritsar, Hoshiarpur, Mahim, Avenashi (Coimbatore), and numerous other towns, furnish instances of the same truth. Almost every village site in the North-West Provinces is in itself a similar example. In the centre are the habitations, clustered together, probably for purposes of defence in past times. Here are the wells,

used alike for drinking, washing, and irrigation purposes. Here, too, the manure from cattle, the sweepings of the houses, etc., are nearest at hand, and are available for the fields closest by, these being also the ones frequented by the people for purposes of nature. As a consequence, it is here that both water and manure are most used, and that the richest and best cultivation is carried on, sugar cane, poppy, castor-oil bean, potatoes, and vegetables of all kinds being grown. This is the inner circle, or "garden" culture. Next comes a circle lying beyond this, but neither so much manure nor yet so much water can be spared for it, and the crops, though still good, are not so good, nor, as a rule, of such a remunerative character, pulses, wheat, barley, and oil-seeds are more general. Next is a third or outer circle, which is only partly manured, and only occasionally watered, and where cultivation is still less high. Lastly, there may be a fourth or outlying part, never bearing more than one crop a year, a summer crop one year, and a winter crop the next. This land gets no manure and no water except the rainfall, and may be termed "dry" land. Thus, one is able to draw, as it were, successive rings or belts round a village, each belt, as it is further removed from the centre, indicating less intensive culture, and also the close interdependence of water and manure. The rent may accordingly vary as I found it do in a village near Bilhaur, from Rs. 30 in the central zone, to Rs. 15 in the second, Rs. 10 in the third, and Rs. 7 in the outlying portion. This was repeatedly pointed out to me by Sir Edward Buck during our tour in the Cawnpore district.

It may be said, generally, that manure goes first to the "garden" land (watered by well), then to the "wet" land (watered by "flow"), and what is over goes to the "dry" land (watered by rain only).

It is not that the soil was originally different in quality, though this may sometimes have been the case, thereby inducing the people to pitch their habitations where it was best, but it is mainly the manure, the water, and the resulting cultivation, that have brought about the change. It would be of little use to extend the supply of water unless there were the manure to back it up. The converse is equally true; at Hissar (Punjab) there is plenty of manure, but it is not made use of because there is not water enough. Bengal, on the other hand, furnishes many instances of an abundant rainfall, but deficiency of manure. As a contrast to both these, Meerut and Hoshnarpur are examples of what can be done by a sufficiency of each, night soil being largely used there in conjunction with well water. Similarly, Amritsar and Poona prove what can be done with canal water and manure. It is a common saying that, if you give a *rayat* water and manure he will grow a crop even upon stones!

119 The Indian cultivator shows by the money which he is willing to pay for manure when able to afford it, that he is by no means ignorant of its value. When he burns the cow dung which he collects, he does it, as a rule, rather from necessity than from want of knowledge of its worth. That, when he has manure,

Indian cultivator not ignorant of value of manure

he often does not preserve it well, or use it to best advantage, is, however, the result of ignorance.

Some spent in
manuring the
land

At Máhim (Bombay) I found that Rs. 96 an acre was quite an ordinary amount to spend in manure for the "garden" crops. Even larger sums than this are expended over *betel* vines, as much as Rs. 280 to Rs. 350 an acre being given out in manure, while for ginger, sugar-cane, and plantains the cost frequently goes up to Rs. 160 an acre. A cultivator thus graphically described to me the effect of manure on the ginger crop he was cultivating, he said:—"I use manure, and 3 or 4 sons come to each plant." At Poona, as much as Rs. 200 per acre is spent on manure for sugar-cane, at Amritsar, Rs. 43 an acre for the potato crop; at Hoshiarpur, Rs. 60 an acre for sugar-cane.

Nor is it in the quantity of manure alone that the Native often displays great foresight. He also often knows *when* to put it on, and for *which* crop to use it. He knows that he must not use it on "dry" land but on "wet" land, where it will decompose. He knows, too, the harm of using *fresh* dung, and that it will attract the white-ants, and that they, in turn, will destroy the crop.

Plan of present
chapter

120. I propose now to review the different ways available in India for manuring the land, and then to see to what extent each manure is made use of, to consider what relation its supply bears to the wants of crops, and how the supply may be improved and extended.

Cattle-manure

121. The most general manure, alike in India and in England, is cattle-manure, or, as made in England, farmyard manure. But, whilst in the latter country it has to be, and can be, supplemented, and even in part replaced, by artificial manures, this is not the case in India, and cattle-manure is the universal fertilizer and often the only one available. When, therefore, we find it the general practice, even in villages, to burn a large proportion of the dung from cattle as fuel, and when, on nearing any town, we may see troops of women carrying in baskets on their heads, the cow-dung cakes or *bratties*, which they have made into cakes and dried in

the sun, we are at once reminded of the fact that a large proportion of the nitrogen which exists in the dung is lost in the burning.

nitrogen be lost in the burning, the cattle are so poor, and so poorly fed, that there is but little nitrogen to lose, for the dung is of very low quality, whilst even what is lost, is recovered in the extra amount of nitrogen which exists in the rainfall in India. Such statements as these have been made, even quite recently, by men who, though not agricultural chemists themselves, have not hesitated to express boldly their opinions on points which they were not able to investigate for themselves, nor were qualified to pass judgment upon. And so it has come about that, from an error as to the amount of nitrogen in the rainfall, many theories have been built up, and but little real investigation has been done. I do not

Statements
made as to the
poor quality of
indian cattle-
manure and
the loss in
burning it.

mean to say that I have been able to investigate the question at all thoroughly, but I have done so sufficiently, at least, to satisfy myself of the incorrectness of many of the theories propounded, and to show that cattle-manure in India is not the poor miserable stuff it has been represented to be, but that it must, and does, lose a very great deal if it is burnt for fuel, this loss *not* being recovered in the rainfall. Even were the latter to be the case, we should have a further difficulty; the districts of slight rainfall, where most dung is burnt (because wood is most scarce there), would get least nitrogen back, for the greater part would be transferred to the more rainy and more wooded tracts.

To satisfy myself on these points, I obtained, through the kindness of Mr R. H. Elliot, of Bartleburghalla, Mysore (whom I was visiting at the time), a number of samples, not only of the solid droppings of cattle, but of the urine and the drainings from manure heaps, also samples of the ashes of the same dung after burning cakes made from it, samples of leaves used for litter, of castor-oil refuse (*castor poonae*), earth nut cake, etc. I must not burden this part of my Report with all the analyses, but, referring to the Appendix for these,* I will now only give sufficient data to enable a comparison to be instituted between English and Indian cattle manure, and to establish such other points as I may wish to demonstrate. The samples taken were sent to London, and analysed in my laboratory there. The cattle dung was composed of the solid droppings of lean working bullocks, taken when fresh and put in a tin box, thus reaching me simply in the air dried condition. Analysis A is my own, analysis B is one by Mr John Hughes, of London, of the sundried cakes, C is a standard analysis of English farmyard manure, D is an analysis by myself of the ashes left after burning cakes made from dung similar in composition to that given in column A, E is an analysis calculated from the results quoted in columns A and D.

My own
analysis

* For full analyses see Appendices D, E, F, G, H, J, K

TABLE VIII.

ANALYSES of CATTLE-MANURE (Indian) and FARMYARD MANURE (English).

Analyses of
cattle manure

	A	B	C
	Dung of Lean Cattle-(Indian) [Air dried.]	Sun-dried Cakes of Cattle-manure (Indian)	Farmyard Manure (English).
Moisture	19.89	7.23	65.17
* Organic matter	69.28	65.32	29.24
† Mineral matter (ash)	21.75	27.46	6.69
	100.00	100.00	100.00
* containing nitrogen	1.24	1.43	.65
equal to ammonia	1.62	1.70	.79
† containing—			
Sand	14.43	19.65	1.76
Oxide of iron and alumina	3.30	—	.43
Lime	1.01	1.06	1.35
Magnesia . . . . .	.41	—	.18
Potash	1.16	.61	.63
Soda . . . . .	.36	traces	.08
Phosphoric acid . . . . .	.17	.54	.31
equal to tribasic phosphate of lime	1.03	1.18	.69

TABLE IX.

ANALYSIS of ASHES of CATTLE MANURE (Indian)

Analyses of
ashes of cattle-
manure

	D	E
	Ashes of Cattle manure (Indian) after burning	100 parts of the Cattle manure (Column A) would approximately contain after burning 40 parts of Ash thus—
Moisture	2.04	}
* Organic matter	2.40	
Oxide of iron and alumina	9.76	
† Phosphoric acid	1.37	
Lime	1.76	
‡ Alkalies and magnesia	2.97	.62
Siliceous matter	80.20	16.04
	100.00	20.00
* containing nitrogen . . . . .	.17	.014
equal to ammonia . . . . .	.70	.040
† equal to tribasic phosphate of lime	1.90	.789
‡ containing potash	2.05	.63

REFERENCES

Analysis B—Journal of the Society of Arts, Vol. XLVIII, No. 1,948, March 21st, 1890, page 141.

Analysis C—Johnston and Cameron's Elements of Agricultural Chemistry and Geology, pages 316, 317, and 318.

I have placed the analysis B, made by Mr. Hughes, side by side with my own (A), and it will be noticed that while the sundried cakes have, of course, less moisture than the fresh dung, yet, taking this into account, the general composition of the two materials is very similar, thus showing that my analysis A is not that of an *exceptional* sample, but of a fair average one. This makes my deductions from column E all the stronger.

Comparing analyses A and C, the Indian dung has, it will be seen, far less moisture, but, as a consequence, the organic matter in 100 parts is very much higher. The large amount of sandy matter in Indian dung is noticeable, but in other mineral constituents, notably phosphoric acid, it is quite as good as English manure, while it has double the amount of nitrogen. This is, of course, taking the two manures just as they are used, and comparing them weight for weight, but to meet objection, even if we suppose the Indian dung to contain, not 19.59 per cent of water only, but 66.17 per cent like the English farmyard manure, the amount of nitrogen in it would be .563 per cent. This is only a little below the .65 per cent of the English sample, and that, by the way, one of well-made dung. Therefore, whether we consider them on the same basis of moisture, or whether we take them as we really have to do with them, i.e., weight for weight, the small value and inferior quality of Indian cattle-manure is by no means established. In this connection it must be remembered that the Indian dung is made without litter, and is merely the solid droppings of the cattle, with more or less earth, whereas English farmyard manure consists of a quantity of litter, as well as of the solid and liquid excrements of the cattle.

Now let us consider what takes place when the dung is burnt. Analysis D shows the composition of the ashes in 100 parts, but, in order to institute a comparison, I have added column E. This is calculated from analysis D, on the assumption (founded on analysis A) that 100 parts of the original dung will leave, after burning, 20 parts (one-fifth) of ash. In analysis A the actual amount of ash was 21.15 per cent; in another analysis which I made it was 20.27 per cent; 20 per cent, or one-fifth, is taken for the sake of convenience. It will be seen that 100 parts of the original dung (analysis A), containing over 59 parts of organic matter and 1.34 parts of nitrogen, lose, on burning, practically *all* the organic matter and nitrogen. The nitrogen is reduced from 1.34 to .034 per cent, in other words, for every ton of cattle manure that is burnt, 29½ lbs out of a total of 30 lbs of nitrogen (97.5 per cent) are altogether lost.

In Chapter V (paragraph 59) the idea was fully combated that this loss was made good by its return in the extra amount of nitrogen supposed to be contained in the rainfall.

Mr Hughes, in the paper from which the analysis B is taken, remarks that, while the nitrogenous organic matters are lost in the process of burning, "the mineral matters, which include the lime, potash, and phosphoric acid, remain

Indian cattle manure is not poor

Great loss results from burning it

97.5 per cent of the nitrogen is lost

"in the ashes, and if these were returned to the land *the only* loss (the italics are my own) would be the 33 lbs. of nitrogen (the quantity in one ton of manure), equal to 155 lbs. of sulphate of ammonia for every ton of cattle-manure so employed." But I would point out that, even were this the only loss, it would imply a very considerable one indeed. The 155 lbs. of sulphate of ammonia, putting the cost of the latter at 12l. per ton, would mean, even in England, no less an outlay than 16s. 7d. to replace the nitrogen thus lost by burning a ton of cattle-manure. Hence the loss is not a slight one at all, but a very heavy one, and, if it costs so much to replace it in England, it cannot be a matter of indifference that so much nitrogen is lost to the soil of India by a wasteful practice. But this is not all, for there is another point that must not be overlooked, viz., that the entire value of the organic (or vegetable) matter is lost in the burning, and this is a matter of no small moment when, as I have shown, soils in India are generally notoriously poor in vegetable matter. Nor even this alone, for dung has an important physical as well as chemical effect on the soil, and it acts as a retainer of moisture. Indirectly it may be said, therefore, that the heat of India is increased by the burning of cattle manure, the soil losing the advantage of the moisture holding material. In some cases the physical or mechanical effect of dung is quite as great as its directly manurial one. This is not possessed by the ashes, and would be entirely lost in the burning. It is not necessary for me to pursue this further than to say again that the statements made as to the small value of Indian cattle-manure, and the small loss that takes place when it is burnt, are incorrect. My analyses are, of course, those of single samples only, but they were taken quite in the ordinary course, and are confirmed by Mr. Hughes' results. I am, however, well aware that much more extended work and enquiry than I have had leisure to make are needed before facts are established for India in the same way as they have been in England. Nevertheless, I shall have shown by these examples how very great is the need of careful scientific enquiry in connection with agriculture, in place of the conjectures and theories of the past.

122. I have spoken of the practice of burning dung as being a general one, and so it unfortunately is; but it is very far from being a universal practice among cultivators, pure and simple. I would go further and say that the best cultivators do not burn dung except out of sheer necessity, and because they have nothing else for fuel, and that, even amongst second-rate cultivators, a great majority will not burn dung if they can help it. Perhaps in all my enquiries there was none into which I looked more closely than this, as I had heard and read such diverse opinions about it; consequently, wherever I went, I did my best to inform myself upon it. As the result, I have no hesitation whatever in saying that amongst cultivators the reason why they burn dung is that they

The organic matter is lost its influence physical and chemical

Cultivators do not burn dung for the reason all said to do so through scarcity of firewood

have no wood, and that if wood could be made cheap and accessible to them, there would be an enormous increase in the amount of manure available for the soil. I can instance place after place which I have visited and where no cultivator burns a scrap of manure for fuel, or where the least possible quantity is so used—generally only a little to boil milk. Comlalore, Salem, Madura, Gujarat (Bombay), Nadiad, Hospet, Hosharpur, and Multan are cases in point. It is where, as in the North-West Provinces, wood is dreadfully scarce, that the practice of burning dung has grown into a habit, and I have been told by people well acquainted with the North-West Provinces only, that the people will never give up the practice, and *must* use dung for their cooking. But what I have seen in other parts, where not a morsel of dung is used even for cooking, or for boiling milk, convinces me that, if firewood were provided, the cultivators would soon come to know the benefit of saving their manure for the fields. Those resident in villages, but not themselves the actual cultivating classes, will doubtless continue to burn dung, and near a town there will always be the inducement of realising something by the sale of cow-dung cakes. The seller does not appreciate that the cakes have cost him anything to produce; that they are really his crop taken off his land, and he returns from the town happy with the two annas or so of *ready money* which he receives in return for a donkey-load or head-load of cow-dung cakes. If he buys firewood, on the contrary, he has to pay money away instead of receiving it. When, however, one gets away from the towns, it will be found that manure is rarely a purchasable article. The reason why dung is used as fuel for cooking and especially for boiling milk, is, I believe, that it gives a slow fire which does not need any attention, whereas a wood fire does. There are also ideas that cow-dung imparts to the food a particular flavour which the people like, but, as I have said, there are many places which I have been to where cow-dung is not even used for this purpose. Cow-dung fuel is a handy form in which a Native can carry fire about with him all day long, for it keeps smouldering away gently, wherever matches are unknown, this fact accordingly acquires considerable significance.

123. I give some instances, from my own observations and instances in the reports of others, which bear out the opinion I have expressed. supp. t.

At Hosharpur there is plenty of firewood and comparatively little dung Punjab is burnt, the cultivation here is by wells. Visiting Rashida, near Multan, where the Sdhnai Canal comes, I found that the cultivators do not burn dung with the exception of a little for boiling milk.

In the North West Provinces as stated the scarcity of wood is, perhaps, North West Provinces. greater than anywhere else and so the burning of cow-dung cakes has become, from necessity almost a habit even among cultivators. But what is more frequently the case is, that for four months November to February, the *royal* makes cakes for burning and during the other eight months the dung is used as manure. Sometimes I have found that the cakes are made during eight months and that the manure is used for the fields the remaining four, in each case the rama determine the date, for during the rainy season cakes for fuel cannot be made.

Thus, a cultivator near Cawnpore, belonging to the *charwar* or leather-dresser caste, told me that he made cakes for three months, and collected dung for his fields the other nine months dating from April 1st in each year. An *Ahar* (goatherd) near Fara made cakes for four months (November to February), but collected manure the rest of the time, except a little which he burnt for boiling milk, and for his pipe (*hoolah*); a Brahman here told us that he burnt as little dung as he possibly could. A *Kuchhi* at Cawnpore, who had dug a well for himself, and grew vegetables largely, made cakes for eight months in the year, and burnt them, but only because he had to pay so much money for firewood. He was in the habit of buying the stalks of indigo and *arkhar* (a pulse) to use out his fuel, and, in addition, he purchased the town-sweepings to put on his field.

Mr Moens, in his Settlement Report of Bareilly, says, "three-quarters of the available cow dung of every village has to be consumed as fuel, for want of wood."

At Basarpur, near Auna, I found that manure is sold to other villages, but the reason of this is, that the village is a cattle and not a tillage one at all.

Bengal

Travelling in Eastern Bengal, in the neighbourhood of Serajunge, I noticed that the general practice among the cultivators was, to have two heaps of dung one for fuel and one for manure.

Mr Sen writes of Burdwan — "In Beerbhoom no good cultivator would think of using his cow-dung as fuel. Everything of manurial value is put in the dung-heap. Here there is plenty of jungle."

Reports from Lohardaga, Palaman, Pichav, and other parts of Bengal say that dung is "not a marketable article," or is "seldom bought or sold."

Central Prov
India,

I cannot give any instance from the Central Provinces in which dung was not regularly burnt as fuel. But, as it is well known, here, if anywhere, the soil requires no manuring, and one would accordingly expect less care in the preservation of dung.

Ajmere

At Biawar, near Ajmere, some dung is burnt, and some is kept for manure. The supply of water is unfortunately, short, and this prevents as much manure being used on the land as might otherwise be the case.

Bombay

At Ahmedabad, firewood is scarce, so is Pe 1 for four maunds of 40 lbs each, and the testimony of the cultivators is, that they gather all the stalks etc. of their fields, and would not burn any dung if they could possibly help it. Poona is another place where firewood is expensive. It has to be carted between 30 and 40 miles, and then costs Rs 5 a cartload, whereas a cartload of cow-dung cakes costs Rs 3, and a cartload of loose cow-dung Pe 1 only. It is not to be wondered at, then, that the cakes are burnt as fuel instead of the wood. The general opinion expressed was, that if the price of wood were halved the cultivators would not burn cow-dung for they fully appreciate its value.

The country around Nadiad is well wooded, and on *Charotar* *Kunds* (the best cultivating caste) burn dung, not even for cooking purposes. Manure is sold out of the town to the cultivators, they paying lie. 1 for 20 maunds (of 40 lbs each).

Mr Iyts says of Gujarat (Bombay) — "Here manures are largely used. Cow-dung is not burnt."

Madras

It was perhaps, in Madras that I found the strongest ground for concluding that cultivators, if they had firewood in sufficient quantity, would abandon the burning of dung as fuel.

At Averashi (Coimbatore) the cultivators do not burn dung at all, but, on the contrary, they buy it from the people who keep cattle, but have no fields themselves. This is not because of any plentifulness of firewood, but because by growing hedges and clipping them, and by gathering all stalks, etc., the people manage to take out their stock of fuel without having to burn the dung. No cultivator at Salem burns dung, although those who live in the town and keep businesses will make up cakes for burning. The same is the case at Shirah.

At Hoper there is plenty of wood, and consequently dung is not burnt, except just a little for boiling milk. Firewood at Mansar (Mysore) is

to be carted 17 miles, and costs Rs 3 a ton besides, this is the sole cause of dung being burnt there

Mr Benson says that in some parts of the Cuddapah district of Madras dung is never burnt

Mr Nicholson, in his "Manual of Composts" goes into the matter at considerable length, and shows that cattle dung is never used as fuel except in towns, and that Mr Robertson (Superintendent of Government Farms, &c.) in his Reports, he said it was

owns Very occasionally a few standing or halting place for carts), but not a hundredth of the cattle dung is so used, partly because the value is perfectly known, partly because fuel for the few wants of the *raiyat* is supplied by hedge and tree loppings, cotton and *Kambu* stalks and so forth

"Village sweepings and cattle-droppings are carefully stored; pots and tiles are burnt with sweepings, stalks, and small wood, but not with bratties"

It should be added that cow-dung is used for plastering the floors and walls of houses, also, that a very large quantity is employed, especially on the outskirts of large towns, for brick-burning.

124 The instances here given show clearly how close is the connection between the supply of firewood and the return of manure to the land. As the result of my enquiries, I feel I may safely assert that where the practice of burning dung as fuel prevails among the genuine cultivators, it arises, in eight cases out of ten, from the scarcity of firewood. The other causes are, a deficiency of water, the land (as in the Central Provinces and silt-renewed tracts of the Punjab) not requiring manure, and, lastly, bad cultivation, which generally means cultivation by castes agriculturally inferior

The fuller treatment of the way in which to remedy the loss of manure caused to the land will be taken in the next chapter, but I may, before passing on, say that the only remedy I can see is the establishment of the "Fuel and Fodder Reserves" spoken of in Chapter IV, paragraph 37. Anyhow, there can be but one opinion as to the desirability of lessening the amount of dung burnt. Sir Edward Buck wrote in 1881 —

"It is manifest that in the interest of agriculture every attempt should be made to minimise the expenditure of manure as fuel"

125. Ashes of dung have a distinct mineral constituents, and they may greater advantage than the dung itself. forcing effect is not desirable, the ashes are preferred, again, in very wet parts, such as Mahim, the cultivators have difficulty in preserving manure, and the most general use they put it to is to burn it for *ráb** (the system of making seed beds for rice, etc.). The unburnt manure would possibly, in such a wet climate, retain too much moisture and keep the soil too sodden, whereas the ashes have a reverse effect, and enable the water to drain away better, thus keeping the soil porous and less saturated.

* See footnote page 24

Again, it is a question still to be determined satisfactorily, whether in soils like black cotton-soil there may not be sufficient organic matter to render the ashes of dung as effective as the dung itself.

I mention these points in suggesting a field of enquiry in which agricultural chemistry can do much good by explaining what does actually take place.

But that the cultivator, when he does prefer ashes to dung, or else the whole dung to the mere ashes, does so simply from fancy or from ignorance, I am by no means ready to allow, but assert that quite the contrary is the case. A cultivator from Tinnevely, whom I interviewed, described to me his practice thus:—"I would use ashes for my nursery beds, and raw dung to get 'produce.'" He added that for heavy land he would use the raw dung, and the ashes for his lighter land. This use of dung for opening heavy land quite agrees with English experience. At Madura the cultivators said to me, "the Native 'knows the unburnt dung is better; there is more 'force' in it." I often think of the answers given to me by two cultivators, one at Salem, the other at Arunachi, when, after they had complained to me of the difficulty of getting firewood, I said to them, for the purpose of testing them, "But why don't you make the dung into cakes and burn them? Then you 'have the ashes left; what more do you want?" The one replied, "What is that? It's only a little; that's not enough." The other said, "If I burn the dung what shall I have for 'manure? How can I live if I burn my cattle-dung? I 'want it all for my garden."

I pass on now to consider other modes of manuring the land.

Sheep-fodder

126. Folding of sheep and cattle on land, for the purpose of manuring it, is another practice understood in some parts, but neglected in others. It has one great advantage, in that the urine is not lost, as it generally is. Folding is practised largely in Coimbatore and other parts of Madras; in the North-West Provinces; in Palaman and Rangoon, in Bengal (chiefly for sugar-cane and tobacco crops); at Rawal Pindi (Panjab), and elsewhere. Sheep and goats are generally used, but cattle are not unfrequently tied outside the pens also, and fodder [principally *cholam* (a millet)] is given to them. The animals are allowed to graze by day over the dry fields, along roadsides and wastes, picking up whatever they can, and at night they are brought into the pens. The pens are moved about every second day. The cultivators pay for the privilege of having the sheep go over their fields, thereby manuring the land. In Tinnevely, sheep are bred largely, and chiefly with the object of using them for manuring the land.

Refuse from
oil seed trash
bag

127. Perhaps next to, but insignificant as compared with, cattle manure, is the use, as a manurial agent, of the refuse obtained from various oil-seeds after the oil has been expressed from them. The principal oil-seeds thus used are the following:—Castor-oil seed (*Ricinus communis*); Gungelly, *Til*, or Sesame (*Sesamum indicum*); Earth-nut or ground-nut (*Arachis hypogaea*);

Kardas or Safflower (*Carthamus tinctorius*), Rape seed, Mustard seed, Niger seed (*Gnissolia abyssinica*), Linseed, Cotton seed. The seeds of the fruits of several trees, such as *Pongamia glabra*, *Bassia latifolia* (the *Makua* tree), and *Melia Azadirachta* (the *Neem* tree), are also pressed, and the refuse is employed as manure, chiefly in the coffee districts. Most of these seeds, after expression of the oil, are also used primarily for feeding cattle, and secondarily for manure.

Castor oil is a plant grown very largely in Gujarát (Bombay), and it is a common sight to see it fringing the fields in the North-West Provinces, also in Bombay and Madras. In Malim, where, in consequence of heavy and continuous rain, it is hard to preserve cow dung, castor refuse, obtained from Gujarát, is used to a surprising extent for the more expensive crops. Thus, for betel vines, from 9 to 12 tons of castor cake per acre costing Rs. 280 to Rs. 380 will be carefully applied in handfuls round the base of the plants, in some 15 to 20 separate doses, for ginger, sugar-cane, and plantains, lesser amounts, but still costing from Rs. 60 to Rs. 160 per acre, are used. Castor refuse is also employed at Poona, Burdwan (Bengal), Hoshiarpur (Punjab), and elsewhere, but in many places it is merely thrown on manure heaps or else burnt as fuel. Its cost varies from Rs. 20 to Rs. 35 a ton. An extensive use for it is found in the coffee growing districts of Coorg and Mysore, where it is known as *castor poonac*.

An analysis which I made of a sample of *castor poonac* from Mysore showed it to contain—

	Per cent.
Nitrogen	4.52
equal to Ammonia	5.49
Phosphate of Lime	2.86

Accordingly it possessed manurial properties of decided value.

Gingelly cake is often fed to cattle, and is also exported. Earth nut is grown mostly in Madras, and especially in South Arcot, it goes mainly for export. Rape seed and Mustard seed are similarly exported. Niger seed is not largely grown but yields a good burning oil, and the residue is used as food for cattle. Linseed is almost entirely an export crop. Cotton seed is generally fed locally to cattle. The other seeds mentioned have mostly only a local significance, but from the flowers of the *Makua* tree (*Bassia latifolia*) a spirit is obtained by distillation, the spent material being used as food for cattle. The fruit of the *Makua* tree, when allowed to ripen, contains a hard seed from which a valuable oil is expressed, and the residue is used as manure under the name *Bassia cake*. For the particulars given as to the various oil seeds I am mainly indebted to Dr. Geo. Watt. Analyses of several of the varieties of cakes are given in the Appendix.*

* See Appendices J and K.

The effect of
export of oil-
seeds on the
soil's fertility.

Now it is clear that as these seeds are for the greater part exported, their export must imply the removal of a very considerable amount of the constituents of the soil. Were they (with the exception of castor-oil seed) to be consumed by cattle, after expression of the oil, the mineral constituents would be returned to the soil from which they were drawn, and the balance of fertility might be maintained. The oil, having itself no mineral properties, and being derived from the atmosphere and not from the soil, is a fitting object for export; but to send away the entire seed, or the refuse after removal of the oil, is to send away the valuable mineral constituents contained in the seed, including those taken out of the soil itself, in brief, to export them is to export the soil's fertility. The answer given will doubtless be that there is the advantage of the *ready cash* obtained in exchange; but it becomes the duty of Agricultural Departments, and of Experimental Farms in particular, to demonstrate clearly to the people what the advantages are of using such refuse materials, either as food for cattle, and thus indirectly as manure, or else by direct application to the land. Where, as in India, supplies of manure in any form are so short, it seems wrong to allow so much manure element to be carried beyond the seas, without endeavouring to establish its value and the importance of retaining it in the country. We in England are not slow to avail ourselves of the advantages this export system offers, and at the time of my leaving for India I was feeding bullocks at the Woburn Experimental Farm on linseed cake, and was also growing crops with rape cake manure. Both these materials, in all likelihood, were the produce of Indian soil, and represented its transported fertility.

Seal or Indigo
refuse

128. *Seal*, or Indigo refuse, consists of the leaves and stalks of the Indigo plant after they have been steeped in order to extract the colouring matter, and is largely used in the Indigo districts of Behar and Beogal by the planters, being, practically, the only manure they employ. Where, as in Madras, the North-West Provinces, and the Punjab, the manufacture is mostly carried on only on the small scale and by Natives, the *seal* is purchased by the ordinary cultivators, and they spread it on their fields. A great deal is so used in the Cuddapah district of Madras. A field thus manured is considered not to need any more manure for the next three years or longer. I saw, near Cawnpore, a splendid field where wheat was growing on land thus treated, and experiments conducted at the Cawnpore Experimental Farm have shown the benefit of the refuse. The cultivators do not like the *seal* when new, but prefer it when nearly two years old. At Rura, near Cawnpore, I found that the landlords (*zamindars*) were in the habit of manuring the fields with the *seal* at their own expense, and then letting them out to cultivators at a high rental.

Green-manure
land.

129. Next to be considered is green-manuring, a practice not unknown, but yet not nearly as widely distributed as it

might with advantage be *San* or *Idg* hemp (*Crotalaria juncea*) is the crop most generally ploughed in, indigo is another, mustard is occasionally used, and frequently on rice fields the weeds are allowed to grow, and then turned in to act as manure. In Lohardaga the favourite green crop is *saxán* (a wild form of *Panicum mitaceum*), it is often grown with rice, and after the rice has been harvested the green crop is turned in and buried in the soil. Green-manuring is well understood in some parts, for example, in Gujrat (Bombay). It is also practised in Hoshiarpur, Burdwan, Hooghly, Chota Nagpur, Poona, and parts of Khandesh. *San* ploughed in as a green crop, in preparation for sugar-cane, is the usual form of green manuring. In other districts, such as Bareilly (North West Provinces), green manuring is quite unknown, in Coimbatore too, so far as the actual growing of green crops is concerned, whilst in many parts of Bengal its use might be more extended. Mr Moens says of Bareilly, "The benefit of ploughing in a green crop is quite unknown here." Experiments made at the Bhadgaon (Bombay) and Cawnpore (North-West Provinces) Farms have demonstrated the advantages of ploughing in green crops such as the *san* hemp or indigo.

130 Over a large part of Madras, Coimbatore included, the spreading of wild shrubs such as wild indigo (*Frigitia tinctoria*), *madar* (*Calotropis gigantea*), *acarai* (*Cassia auriculata*), *kolins* (*Tephrosia purpurea*), convolvulus, and the shoots and leaves of *Pongamia glabra* and other trees is much used on "wet" lands, principally on rice fields. The shrubs and leaves are spread green on the fields, and then trodden in by foot. At Hospet, which is served by a canal, led by a weir or *amsut* from the river Tungabhadra, and where the cultivation is exceptionally good, I saw this plan of green manuring being carried out. Trees are grown round every field and along the banks of the water-channels, and are defoliated once in three years, the twigs and leaves are spread on the land where rice is to be sown, canal water is let on, and the twigs are trodden into the soil with the foot. About eight days later, rice is sown broadcast on the top. It is worthy of note that, though served by canal irrigation, the compartments or beds in which the water is enclosed are here quite small, just as in "garden" cultivation.

The practice of putting twigs and leaves on rice fields is largely adopted in Tinnevely. Branches and leaves are used as manure near Bangalore in April, and at the end of the monsoon. When touring in the Suni Valley (Punjab) Dr Watt pointed out to me a shrub (*Adhatoda Faisca*) which acts as a weed-exterminator, the natives spread it, when green, on their rice fields, and it is said to kill all the weeds in 24 hours. At Mahim the leaves of the sugar-cane are spread on the ginger beds to act as manure, leaves are also put round the plantains. Near Rura (North West Provinces) I saw a cultivator using leaves as manure on his opium beds, and he thought very highly of them. In the Forests of North Kanara and along the Malabar coast leaves are gathered and used as manure. Leaves are, generally speaking, collected in

Use of twigs
and leaves as
manure

the neighbourhood of towns and villages for the purpose of "parching" grain.

I believe that in these various ways of green-manuring, the *physical* improvement of the soil is an important point. At the same time it shows that the value of vegetable matter, as an addition to the soil, is not neglected by the *raiyat*, although some would maintain that its loss in the burning of cow-dung is of no account.

The *ráb* question.

131. Associated with the use of twigs, leaves, etc., for manure is the system of seed-bed cultivation termed *ráb*.* This system is employed mainly in the Bombay Presidency throughout the districts of heaviest rainfall, but it is not unknown in parts of Bengal. The crops for which it is chiefly used are rice and a millet called *nágli* (*Eleusine Coracina*). The word *ráb* literally means "cultivation." The process consists in heaping on the spot selected for the seed-bed successive layers of cow-dung, tree-lopplings, shrubs, leaves, and grass, with earth on the top to keep all down; the heap is made about three feet high, and then the whole is set fire to.

Mr. Ozanne's experiments in Bombay

As regards the advantage, still more the necessity, of *ráb*, there have been continuous contentions between the cultivators and those who have supported them, on the one hand, and the Forest Department on the other, the latter maintaining that the practice is a wasteful one, and that the lopping of trees injures the forests greatly. In 1885 a Forest Commission was appointed in Bombay to enquire into the matter, and Mr. Ozanne, Director of Land Records and Agriculture, Bombay Presidency, conducted a number of experiments, which, though not absolutely conclusive nor complete, went far to show that the *raiyat* in *ráb* areas was adopting the only ready means by which he could cultivate his rice crop with profit. Great credit is due to Mr. Ozanne for the energy which he showed and the line of enquiry he adopted. He pointed out that there are defined limits to *ráb* cultivation, *viz.*, the districts where rainfall is very heavy and also continuous. For example, *ráb* exists in the Konkan, whereas in Dharwar, where the rainfall is less heavy, it does not. Similarly, *ráb* is not used where there is tank irrigation, for by the aid of the tank the seed can be sown before the heavy rains come. Mr. Ozanne's experiments also showed that brush-wood and shrubs when used as *ráb* material give just as good results as boughs of trees do, and that there is nothing in the *raiyat's* belief in the superior virtues of particular kinds of trees. Cow-dung (which the *raiyat* prizes most for *ráb*) gave the best results of all; the supply of it is, however, limited; but, with the aid of brushwood, shrubs, and grass, the cultivator can make up the necessary amount for burning. In this way the Forests had, up to the time of the enquiry, been of great use to agriculture.

It is undisputed that *transplanted* rice gives far and away the best return, and that only the finest kinds of rice are so sown. At

* See footnote, page 27.

Igátpuri, where, owing to scarcity of *rd̄b* material, a good deal of rice is grown from "sprouted" seed (the seed being allowed to soak for two days in water before sowing), the out-turn is not so good as at Kalvan where *rd̄b* prevails. If seed is "sprouted" and sown, but the rain does not then last, the seed is wasted, but *rd̄b* seed is not put in the seed-bed until the rain actually comes. The assessment of the land has of late been lowered at Igátpuri, on account, it is believed, of the difficulty in getting *rd̄b* material, and the consequent lesser yield of rice. Rice though aquatic, cannot stand immersion, and it is noticeable that where *rd̄b* is practised the seed-bed is always on elevated ground. Rice cannot be sown in the wet, as it would rot; this accounts for *rd̄b* being used at ty of preserving the the seed-bed it would burning the dung on the land a drier and more porous soil is obtained.

At first sight, I allow, one would conclude that the practice ^{The advantage of *rd̄b*} must be a very wasteful one, but the fact that it is carried on by *raiya*s, such as those at Máhim, the excellence of whose cultivation excited my highest admiration, obliges me to conclude that, though I cannot explain *why* it is, yet it is the *one* way in which the cultivator can grow his rice to best profit. I cannot believe that men who unusually spend such large sums as these cultivators do in the purchase of castor refuse, etc., would burn their cow-dung for *rd̄b* if they had not found out by experience that it was the best plan to adopt. In other words, I am content to learn from practical experience, and to endeavour to explain the science from the practice.

It is not at all unlikely that much of the benefit of *rd̄b* is due ^{Possible explanation} to the change produced in the mechanical texture of the soil by the burning which it undergoes. This results in the liberation of some of its dormant constituents, and the supply of ready-formed food for the plant, which, at this stage, needs to be quickly forced on; then, again, the addition of mineral matter from the materials burnt must conduce to the richness of the soil, and, while supplying plant food, would, at the same time, render the soil porous, so that it would not retain excessive moisture, as might be the case were natural manure or green leaves to be used. There is a further possible benefit in the destruction, through burning, of any weed seeds which might choke the rice in its early stages. I find it stated in the Lohardaga Agricultural Report that:—

"for paddy nurseries, in many parts the manure heap is set on fire first, the motive being to kill grass seeds, which, where the soil is poor, would germinate and kill the rice, but this is not done in Five Parganas, since the land is fertile there, and the young crop grows up strongly enough to keep the weeds in check."

This instance from Bengal may afford a possible explanation of what takes place in other parts. The whole subject of *rd̄b* is an interesting and important one, about which there is still much to be learnt, and on which the scientific agriculturist may usefully work.

Manuring by
silt, or by soil-
mixing.

132. Another system of manuring is that by using silt, tank mud, etc., or by the mixing of soils of different character, in order to improve the texture of the land.

Silt from rivers,
streams, and
canals

Vast areas in Bengal are annually renewed naturally by the silt of rivers, and there are in the Punjab, for example, near Gujrat, stretches which are covered yearly by the silt brought down by mountain streams. In the Jhelum and Shabpur districts, at the foot of the Salt Range, there are similar tracts, here the fields are first embanked, and then the flood water of hill torrents is turned into them through an opening in the upper end of the embankment. The water is allowed to flow in until the field is converted into a pond. When this dries up, a crop is sown, and requires no further watering or rain. In this way the wheat-growing

In Behar a large proportion of the land is inundated, and the soil is washed from the higher to the lower land, the latter consequently not requiring manure

Jute-growing in Eastern Bengal is carried on by the annual renewals of silt from the rivers, and where it comes no manure is needed at all.

It is found that wherever there is silt the *rayat* does not value ordinary manure or take trouble in preserving it, he looks for the silt to come instead

In the case of silt-laden canals one reason for the excessive use of canal water is, that the more water that is used the more silt is there deposited, and the people alongside canals have been known

The use
for re-

Great distinctions are drawn by the cultivators between the rivers and canals which bring silt and those which do not. Thus, the Sutlej is a snow-fed river, and brings sand rather than mud, the silt of the Jumna is considered fertilizing, that of the Ganges is not.

Soil mixing

... and from tanks ...
... going
... one
... jute
... pond
mud might be mixed with a sandy soil.

At Nadiad (Bombay) I noticed another kind of "soil-mixing." Here the fields are all surrounded by hedges growing on embankments. When it is required to turn a field into a rice field, the topsoil is thrown from the centre up against the hedge, thus making an embankment; the level of the field is lowered thereby, so that the rain water, when it falls, is held up and soaks the soil thoroughly. When, in turn, the field requires to

be manured, the soil is thrown back from the hedge side on to the field and is spread over it

133 Nitre or saltpetre (nitrate of potash) is a salt with which the soil in many parts of India is impregnated, and the manufacture of nitre, together with some common salt, by a somewhat crude process of extraction and purification, may be seen very frequently. Though the manufacture is widely distributed, it is in Behar and the North-West Provinces that most nitre is made. The earth around the remains of old villages is specially found to be thus impregnated. The accumulations of the salt in all probability have their origin in the natural process of nitrification (production of nitrates) which the solid and liquid excreta of cattle and men, as well as vegetable and other refuse, have undergone. Wood and other vegetable ashes supply potash in the form of carbonate of potash, which then combines with the nitrates, producing nitrate of potash. The potash in the soil itself, more especially when the soil is clayey in nature, no doubt, contributes also to the production of nitre. This explanation accounts for the nitre containing earth being found mainly where habitations formerly stood.

Nitre or salt
petre

Its method of
formation

The men who manufacture the salt know by tasting the earth whether it will pay them to work it or not

Nitre as a manure is but little used, owing to its high price. Experiments at Government Farms have shown that it gives a considerable increase in the out turn of cereal and other crops, but these experiments, like several others, have not been conducted with a view to seeing if the extra return would pay for the expenditure, and if there be a likelihood of the *rasyat* availing himself of the manure. The price of crude saltpetre varies in Behar from Rs 1 As 8 to Rs 3 per maund (of 80 lbs), but the lower-priced kind would be very impure. Generally speaking, it may be said that its cost locally is Rs 2½ to Rs 3 per maund of 80 lbs. This is the price at Cawnpore, also at Salem (Madras). In Gujarāt (Bombay) nitre costs nearly Rs 5 for the same weight, and delivered at Calcutta, the price is from Rs 5 to Rs 6½, according to quality.

Price

The price of saltpetre, accordingly, puts it quite beyond the reach of the ordinary cultivator, and it is only in the case of crops which bring in a large monetary return, such as sugar-cane, coffee, tobacco, opium, and indigo, that it has any chance of being used in the country. Thus, it becomes almost exclusively an article of export, principally to the United Kingdom. In Coorg, among the coffee planters, a small amount is used as manure. Occasionally, too, the Natives will use the nitre containing earth itself as a manure, spreading it round the base of the sugar-canes, etc. I saw the earth being used for canes at Hosharpur, and also for wheat at Ilissar. An efflorescence of nitre often appears on the walls of houses in villages of the North-West Provinces and Oudh, as well as on the earth around them, it is then scraped off and used as manure.

Use as manure

Reference has been made in the last chapter (Chapter VI, para-

Well water con-
tains g. rates

graph 99) to well water which is termed *khara* by the cultivators, and which is held in special repute for tobacco growing. Nitrates, as I have shown in the analyses there quoted, hold a very prominent place in the composition of such waters, although, in that instance, rather to my surprise, I found that they existed as *soda* and not as *potash* salts. It is quite possible that nitrate of potash occurs in other cases, but the subject needs more complete investigation. In another instance, when at Avenashi, I noticed a white crust on the soil, and the cultivator said that it was prejudicial to his sugar canes; he added that it came from the well water. He did not grow tobacco here because the water was not of the kind of *brackishness* he liked. As far as I could tell from a cursory examination, the saline crust on the soil was sulphate of soda, but whether it came from the water or from the soil no one could tell me. I only mention this to show that the Native clearly discriminates between the properties of different waters, though he does not know whence they arise, and also to show the amount of useful work that could be done by a chemist who would investigate these various points.

Wood ashes

Other sources of potash are wood ashes and the ashes from burnt cow-dung cakes, these, as we have seen, are not wasted, but generally find their way on to the manure heap.

Lime

134 Lime is seldom, if at all, used as a manure. Nor, as we have seen in Chapter V (paragraph 68), is its use generally required, the soils of India, as a rule, containing a sufficiency. Were there to be need of its special application, an abundant supply would be found in the concretious limestone known as *lanhar*, which in so many parts underlies the soil.

Kankar

Gypsum

A further supply of lime in another form, is available from the vast beds of gypsum (sulphate of lime) found in the Salt Range in the Punjab, which are capable of supplying almost inexhaustible quantities of lime. Some experiments that have been carried out seem to point to the possibly profitable use of gypsum as a manure for indigo, and support for this may be found in the following analysis of gypsum as a manure for indigo.

Indigo, like the soils of Coorg, lacks lime in the soil. I am confident that lime, where put on, has done good. Unfortunately, it is in these parts that lime is hardest to procure. In Coorg and Mysore a compost for coffee is made out of the pulp from the coffee berries mixed with lime, soil, etc.

Phosphatic manures.

Few mineral sources discovered

135 Bones are practically the only source of supply of phosphates to the soil. Small quantities of apatite and phosphatic nodules were found by Dr Warth and Mr Parsons at Mussoorie (North-West Provinces) in 1884, and by Dr Warth, in the Eocene of the Eastern Salt Range. Coprolites have been discovered in spots in East Berar and the Upper Godavari district in Hyderabad, but nowhere in anything like sufficient quantity to be profitably worked. Nothing else that I know of in the way of

raw phosphatic material for manufacture into manures has been found in India.

Fish manure, which may be considered partly a phosphatic manure, is prepared in parts along the sea coast, such as Mangalore (Mysore), and is transported inland within certain distances, being used almost entirely by the coffee planters of Coorg and Mysore.

I pass now to the more important consideration of the use of bones.

136. Bones, as is known, are very extensively exported from India, and are but little used in the country itself. The question whether the export of bones should be allowed to continue without a strong effort being made to retain this source of manure in the country, has been prominently brought forward of late years, and the Government of India recently caused enquiries to be made as to the trade in and use of bones. The general reply received was that the export was an increasing one; that the trade was carried on entirely by European capital, and that the actual collection of bones was done by Muhammadans and low-caste Hindus; that it was principally confined to districts served by railways, and from villages within an easy distance of the line, and, lastly, that bones were not used by the native agriculturists. It is estimated that 60 million cattle die or are slaughtered annually in India. The export of hides and skins amounts to over 30 million yearly, though this number is not an increasing one, for more raw hides have been used in the country itself of late. In 1888-89, as also in 1889-90, 6½ million raw hides were exported from India to foreign countries, 1½ million dressed hides, 4 million raw skins, and 19 million dressed skins. Whether taken from the number of hides or from the estimate of the cattle that perish, it is evident that there must be a very large supply of bones available. Hindus, however, being largely a non-meat-eating people, and regarding the bones of cattle as those of their ancestors, and hence sacred, are prevented by their caste prejudices from collecting or utilising the bones. Ninety per cent. of the Hindus may be said to be non-meat eating, and, of the remaining 10 per cent., fully 5 per cent. cannot afford to get meat. The consequence is, that the bones are left lying about wherever the animals may happen to die, or are thrown into ditches (*nullahs*) and ravines and left there. It has also to be remembered that

factured into artificial manures, is valued highly. The exports of bones from India have been, in round numbers, as follows:—

Year.	Tons.	Year.	Tons.	Amount exported
1884-85	18,000	1887-88	26,000	
1885-86	22,000	1888-89	35,000	
1886-87	18,000	1889-90	44,000	

Of this total, above one third goes from Bombay, somewhat less

from Karachi, and almost all the rest from Bengal (Calcutta). Madras exports only a small amount, and that mainly to Ceylon. The total value of the exports in 1889-90 was Rs 24,27,489. Out of the 44,000 tons exported in 1889-90, close upon 40,000 tons went to the United Kingdom, and 2,200 tons to Ceylon. Thus, the trade may be considered one almost entirely with the United Kingdom, and yet, despite this large influx of bones, it amounted, in 1888, to only about one fourth of the total amount of bones used annually in the United Kingdom.

For the statistics here given I am indebted to Mr. J. E. O'Connor, of the Finance Department, Government of India, and to Mr. H. Voss, of the Anglo-Continental Gunpowder Works, London.

The collection
of bones

The collectors of bones are mostly coolies of the *Chamar* caste. The bones are roughly broken with a hammer, conveyed to the nearest station, and there left for removal by train. Bones may be seen lying in heaps at a great number of the stations along the railway routes and waiting for removal to Calcutta, Bombay, and Karachi. Villages within a 10 mile radius of the line have been already cleared of any accumulated stores of bones, but collection of fresh bones goes on, although it does not as yet extend much beyond this limit. The collection of bones is thus a limited one, but, as railway facilities increase, so will it spread. In Bengal, where a damp, hot climate prevails, bones seldom lie long on the ground, but disappear within a couple of years; in the hot, dry plains of the North West, on the other hand, they get desiccated and bleached, and may thus last a long time and accumulate. Those accumulated stores, however, have now, for the most part, been already carried off.

What prevents
bones from
being utilized in
India?

(1) Prejudice

137. I will now consider what stands in the way of bones being utilised in India for agricultural purposes.

In the first place, however, will not

so. In the business office of a bone exporting firm I myself saw the different samples being handled by a Brahman.

(2) their value
not sufficiently
known

Secondly, the value of bones for agricultural purposes has not been definitely shown as regards India. It seems hard to believe that there should so long have been this available source of manure, and yet that the *raiyat* everywhere should have been quite ignorant of its use. He utilises most of the materials that he has at hand, and even as regards those which prejudice has prevented him from using largely, night-soil, for instance, he is perfectly well aware of their fertilising value. But it is not so with regard to bones, nor have the experiments conducted on the Government farms at Cawnpore and Nagpur succeeded in establishing the value of bones, nor in showing that it would pay the *raiyat* to collect and use them. I do not say that the enquiry is complete, but it is clear that the benefit of bone manures is not of the marked nature in India that it has been found to be in some parts of England. When

looking for a possible explanation my attention was drawn to analyses of Indian soils. As I have pointed out in Chapter V (paragraph 65), these, as a rule, contain considerably higher percentages of phosphoric acid than most English soils do. Now, phosphoric acid in the form of phosphate of lime is the chief ingredient of bones, and the one for which their use in agriculture is prized. Again it is necessary to point out that bones, or even bone manures, are not of *universal* benefit even in England, on *some* lands, and in certain parts of the country, there is nothing that does so much good, in others they and the money paid for them are thrown away, and quite as good a result would be obtained by using the cheapest mineral superphosphate. No practical farmer and no agricultural chemist has ever yet been able to determine exactly why or when this is the case, but it remains a fact that the application of bones has really to be made experimentally at first in order to see whether they do good, then, if they do, they generally pay well. But each man has to get to know his land, and to learn by experience whether bones are good for it or not.

Now let us take the practical difficulties apart from caste prejudice, and let us suppose for the moment that the value of bones in India had been proved. The whole export is little more than one fourth of what the United Kingdom annually requires. What would this amount to, therefore, if spread over the whole of a vast continent like India? It would not be much more than a drop in the ocean!

Again, while it may pay a trading firm to send out collectors of bones, it does so only along rail served tracts, and within a certain radius. We have to see how the *rayat* would be affected. The death of one of his cattle is, happily for him, not an every day occurrence, and when it does happen, it is only about 20 seers (40 lbs) of bones that are yielded. What is the *rayat* to do with these? Is he to store them until another of his cattle dies and so on, until enough are accumulated to make it worth his while to break them up and manure a field with them? Or is he to roam over the wastes and ravines and pick up single bones? If the use of bones is to be general, there would be others doing what he does, and how far would the bones go then? He would, again, find himself in competition with the pul agents of exporting firms, as soon as the extension of railways or the difficulty of getting a sufficient supply of bones near at hand had obliged the search to be made further abroad. It must come to it, I think, that the most that the *rayat* will do will be to throw the bones on to his manure heap, even if he takes the trouble to do that.

Next, there is the difficulty of preparing bones for use. Suppose the *rayat* were to collect a sufficient supply and to keep them separate, how would he prepare them for use? Some kind of grinding is necessary, or the bones could not, so experience tells us, be used to advantage. Unless bones be ground to a coarse meal, it is impossible to secure their proper

(c) difficulty of collecting and keeping

(d) difficulty of preparing & use for use

distribution over the area to be manured, nor can the forces of nature so easily act on them and disseminate them throughout the soil as plant food. The old idea in England was, that bone was a capital manure because it lasted well, especially if after a number of years a piece of bone could still be found in a field. This idea, has, very rightly, given place to the more scientific one, that a profitable return must be the one which is readily reaped in the crop and not merely stored up in the earth. Accordingly, the *factness* of agricultural bone meal is now insisted upon. The *rayat*, however, cannot afford to pry for a bone-mill and he has no really available means for reducing the bones to a small size. On two occasions I have seen bones being broken up by hand, this happened on the estate of Mr. Sabapathi Modhar at Bellary, and at the Seebpore Experimental Farm, Calcutta. At the former place women were employed in pounding the bone, and I was told they would make 100 lbs of bone into meal in a day. At Seebpore three men using a *dhraki*, or kind of lever hammer worked with the foot, made 20 seers (40 lbs) into meal in 5½ hours. It is possible that if the value of bones be clearly shown the *native cultivators* may begin to break up the bones that lie near at hand, but that the practice will become a general one, or that if a general one, it will be capable of supplying the manurial requirements of the land to any great extent, I am inclined to doubt.

Prospects of
bone as an
object of sale to
find a market

It has been suggested that bone mills might be started up country, and the bones be sold to the *rayat* rather than sent for export, but then comes in the *rayat's* difficulty, his want of capital. He has seldom money to pay for manures, especially those the value of which he is not convinced of. And, in any case the whole matter would be one of market considerations. If there is a constant and increasing demand for bones, the price of which in Calcutta is now from Rs 40 to Rs 45 a ton (say 3½ to 4½ lbs a ton), they can only be kept in the country if those who are likely to use them are willing to pay as much as this or more, and where is the money to come from? A tea planter, or a coffee planter, perhaps, may find it worth his while to purchase bones, but it is only crops that yield a high return that will justify their use. In such cases the planters generally have their own bone crushing mills worked by steam, but, even in the midst of the indigo cultivation of Behar, I met planters who regularly collected and bagged bones for export, finding it more profitable to do so than to grind them up and use them on their land. Railways will not do so much to distribute bones as to afford an outlet for them, in other words, they will facilitate the export.

It is necessary to add one caution more,—as the demand for bones for export purposes increases, it will afford another inducement to the professional cattle stealer and the cattle poisoner. Already the hide is an attraction, the flesh is rapidly becoming one also, if to these are superadded the

bones, more care will have to be taken in the future to protect the cattle of the country.

The whole question of the export of bones is, therefore, I hold, under existing circumstances, one purely of *market* considerations. The use of bones in India a matter of market considerations

138 The next subject, that of imported manures, which in an account of English agriculture would fill a most important place, may, so far as India is concerned, be very summarily dismissed. If natural manures, such as bones, are not yet likely to be used, still less so are artificial manures. Not only have no sources of the raw material been discovered which would pay for working, but the acid (sulphuric acid, or oil of vitriol) required for their manufacture, costs, at present, far too much. Over and above would be the cost of carriage both of raw and manufactured material. Once, again, the real difficulty comes in, who is to pay for these? Only crops giving a high return could possibly meet the outlay, and, owing to lowness of price for produce the tendency among planters towards economy in artificial manures has of late been merited. The day is still distant, I believe, when artificial manures can be profitably used in India. Some great change, either in the cost of manufacture or in the condition of the agricultural classes, must take place first. A leading firm of chemical manure manufacturers told me, before I went out to India, the result of their efforts at introducing artificial manures into Russia and the East. The only manure which they succeeded in getting into use in Russia was the cheapest mineral superphosphate, and then only in the enlightened Baltic Provinces, where the farmers were, for the most part, Germans. While, however, there may be no immediate opening for artificial manures, it behoves those concerned in agricultural welfare to be on the watch for any developments that may take place. For this reason I consider that the presence of an agricultural chemist would be of service in possibly discovering and in utilising fresh manurial sources. Artificial manures

139 In connection with the extended use of manures, whether for employment in the country or for export, it is well to point out that the practice of adulteration has already been introduced. This is the case with bone-meal. For the purpose of competing against the well-known firm, Messrs Croft, Wells & Co., some of the native Hindu and Parsi merchants resorted to the mixing of bone meal with shell sand, lime, and similar cheap materials. After inspecting Messrs. Croft, Wells & Co.'s bone crushing mills at Thana near Bombay, I was taken to the Mazagon Dock, Bombay, where, at and around the landing-stage, were several small establishments belonging to native merchants, and provided with bone-crushing machinery. At some of these works I saw heaps of the shell sand, lime, etc. referred to, and of the bone meal to which these were added. I was enabled to get samples of the materials so used, and I gave analyses of them in the Adulteration of manures.
Bone-meal.

Appendix * They consisted, in one instance, of shell-sand, in a second, of burnt magnesian limestone, or substances akin to it. Naturally, a business such as that which Messrs Croft, Wells & Co carry on will have its imitators, and unfair dealings may be used in the competition. In this way the reputation of Indian bone-meal as exported to England may be prejudiced, in the same way as that of Indian wheat has been. It is only, however, by purchasers insisting on receiving a definite guarantee of composition and purity, that security in transactions can be obtained.

Oil-cakes

The adulteration of wheat and oil seeds will be considered later on, but, so far as my acquaintance went, bone meal was the only *manure* which I found to be adulterated. It is well known, however, that rice cake, when obtainable in England, is almost always mixed with a quantity of sand and earthy matter, although it is not clear where the actual admixture takes place.

The presence of a chemist would be a means of detecting, and probably of checking, the practice of adulteration.

Points in which the soil is not fully utilized or does not use the manure as it has facilities to do so

140 Having now reviewed the manurial resources which are in more or less general use, I pass on to consider two main points in which the Indian cultivator does not make full use of what he has at hand. These are, firstly, the non utilization of night soil, secondly, the imperfect conservation of the ordinary *manure* from cattle.

Importance of the utilization of night soil

141. It is undoubtedly the case that a very great improvement might be effected in Indian agriculture if the system of utilizing night-soil, sweepings, etc., were universal. Of special importance does this become in a country which, as we have seen, is too poor to purchase artificial manures, or even to retain in it the bones now sent for export. Still more so when, as in the case of India, not the *crops* alone (such as wheat, linseed, and other oil seeds) are exported, but also the very *manures* which might be supplied in the refuse from the oil-seeds after the expression of the oil.

Mr Nicholson's estimate of the population of the district

Mr Nicholson, speaking of Coimbatore, estimates that a population of 1,350,000 persons takes yearly from the soil, for food, 330,000 tons of grain, and a lot of other produce, of this but little is returned to the land. Mr Nicholson sums up his remarks in terms with which I thoroughly agree.

Sanitation of towns

I regard the spread of a good system of utilizing human and household refuse, street sweepings, etc., on the land, as a most potent factor in the improvement of Indian agriculture, and having had among other duties to enquire into different schemes for town

sanitation I must record my conviction that the *dry* system is the one best suited to Indian circumstances, and that any system which diverts from its proper destination, the land, that which has originally come from it, would be attended by loss to the cultivator and to the State, and would not be satisfactory from a sanitary point of view.

142 Prejudice is the great bar to the proper utilisation of night-soil. It is not that its use is confined to the fields nearest to any town, but that a tall crop, such as *arkhar* (*Cassia*), which has come to its turn for receiving manure. On these fields the crops are manifestly better than the rest, what is wanted is a greater distribution of these fields. The hope for improvement lies in the gradual breaking down of prejudice. That there are signs of this going on is evidenced by the fact that in certain towns, such as Larkhated, Cawnpore, and Nagpur, the utilisation of night-soil has had an indigenous origin, and its spread has been due to other cultivators following the example set. It will be, on the one hand, by the force of example, and by the necessity of adopting the most remunerative methods, and, on the other hand, by the breaking down of prejudice through the spread of education, that, by degrees, the ready and natural means of replenishing the land by the use of night-soil will come into general use.

143 In a great many towns and villages it is the practice to utilise the sweepings of the houses and streets, but not the night-soil.

The utilisation of night soil has very great agricultural advantages. To the cultivators, the increase of food to towns and villages and an increased revenue to the State. These instances will afford evidence of that the capabilities that exist for the improvement of Indian agriculture *from within*.

To take, first, cases where the practice has been indigenous in

Larkhated,

(1) Cawnpore

It realised Rs. 31674. The price varies with the demand but is about Rs. 2 per cartload of 700 lbs., say Rs. 6 a ton.

The urine and sullage water is not utilised as it is at Amritsar, but is allowed to flow into the river. It would be well, I think, both for the sake of

(j) Cawnpore

by the Municipality, and poured (k) Allahabad
at the top. Two and a half acres are
vastly improved both manurally and
one and open whereas beforehand it

was hard and lumpy.

I read that four Municipalities in Behar have begun to dispose of night-soil on land and have realised profits by re-letting the land. In Gya the profit is Rs. 100 to Rs. 150 yearly, in Mozufferpore, Rs. 120, in Buxar, Rs. 84.

At Madura (Madras) night soil is mixed along with the town sweepings in the municipal refuse. The latter cost about Rs. 2½ a ton and it is reported that the prejudice against it is passing off.

144. At Ferozepore (Punjab) I saw in use the system of sanitation which I consider the best for village latrines. It is the plan of having shifting screens or enclosures, made of bamboo, and within the enclosed area a shallow trench is dug, earth being thrown over at once by the attendant. The screen is moved daily, and in this admirable way the land gets manured evenly and regularly. Subsequently it is ploughed up, and crops (mainly vegetables) are grown.

Suggestions
for a large scale
trial on

What is worthy of
attention is that the Agricultural Association
soil, etc., should
be collected by village servants, hereditary or hired, and be sold to the villagers as manure, the proceeds going towards payment of the expenses of keeping the village clean. If there were some system of this kind inaugurated it would soon prove an agricultural benefit.

Where night-soil is to be disposed of to the cultivators, the system in use at Amritsar seems to me to be the very best of all, especially as it provides for utilisation of sullage water, urine, etc. Still, it may not be possible to adopt it everywhere, and the Poona plan of making *padrette* may sometimes be found the most practicable. If night-soil has to be trenchel, I think that there is no necessity for the deep trenching so often employed. A depth of 1½ feet of earth, or even 1 foot, is not called for, earth is a capital absorbent and deodoriser of night soil, and a thin coat-

ing of it on the top of the night soil is sufficient to prevent any smell. If a foot or more of night-soil is put in a trench it is apt to form a scum and to dry on the surface whilst remaining moist below, consequently it does not amalgamate well with the earth. If, on the other hand, a depth of only two or three inches of night-soil be used it is much more quickly incorporated with the soil, and the land is earlier ready for sowing, or for trenching again.

General neglect
of use of night
soil.

145 Although the foregoing cases of the utilisation of night-soil have been named, they are exceptional, and there is still a general neglect, throughout the country, of this useful source of manure one doubly useful because it is at hand and has not to be purchased.

Throughout Bengal, for example, night-soil is, as a rule, not used at all, in Surat (Bombay) and Ahmedabad town sweepings are regularly used, but not night soil. Similarly, in Madras I found that at Shiyali, Salem and Arcachin, only the sweepings were used. In some places there was no one to collect the night-soil, in others, there was a general idea that a crop would not grow with it, though the experiment had never been tried, in others, again, no one would touch the material. In brief, in almost all the villages which I went to, and in whatever Presidency, as soon as I asked the question whether they made use of the night-soil, the cultivators shrugged their shoulders and turned away.

But I believe that, in time, a change will come, and, if reasonable arrangements be made, and the example given elsewhere be wisely enforced, there will undoubtedly follow distinct agricultural improvement.

146. The second point in which the cultivator does not make full use of what he has at hand is in the conservation of the ordinary manure from cattle. Excellent as in many respects his cultivation is, yet in this matter of manure he is far from perfect. The manure of his cattle

is, in fact, one of the worst handled in which he can be shown a better way. Perhaps in no respect has the British farmer of recent years advanced so much as in the economy introduced by the proper making of farmyard manure. The superiority of box-made manure to that of open yards needs no explanation. The manure is made in a box, and the urine is caught in a cake of all

different, no litter is supplied to the cattle, and not once in a thousand times is any attempt made to save the urine. The solid excrements are picked up, and either made at once into cakes for burning, or else they are thrown on the manure heap, such as it is. The urine sinks into the ground, generally in the hollows worked out by the animals' feet. Now and again a little of the softened earth is scraped away and thrown on the manure heap,

Imperfect conservation
of cattle manure

The urine
wasted

but it results in little more than a deeper hollow being made, and serves to expose a fresh surface for the urine to sink into. The value of the urine is, I am sure, not only not fully appreciated, but is actually unknown to a very large number of the cultivators. Did they know its value they might do something more to save it

I give here an analysis of a sample of Urine taken direct from Indian working bullocks, at the same time and under the same circumstances as the sample of dung, the Analysis (A) of which is given in paragraph 121 of this chapter [Table VIII]. For the sake of comparison I give a standard analysis of cows' urine (English) *

TABLE X

Analyses of
urine.

ANALYSES OF URINE from INDIAN BULLOCKS and ENGLISH COWS

	Y	G
	Urine of Bullocks (Indian)	Cows' Urine (English)
Water and evaporable matters	90.63	91.59
* Solid residues	9.34	8.40
	100.00	100.00
* including mineral matter (ash)†	1.74	
† contains—		
Sand . . . . .	.01	
Lime . . . . .	.03	
Magnesia . . . . .	.37	
Potash . . . . .	.43	
Soda . . . . .	.02	1.00
Phosphoric acid . . . . .	.028	
Total nitrogen	1.164	.90
equal to ammonia	1.418	1.09

TABLE XI

Analyses of
leaves used for
litter

ANALYSES OF LEAVES used in MYSON for LITTER

	H	J
Moisture	10.3	10.72
* organic matter	74.11	81.00
† Mineral matter (ash)	10.43	4.00
	100.00	100.00
† containing—		
Phosphoric acid	1.07	.23
Potash	5.33	.04
Soda . . . . .	.73	1.00
* containing nitrogen . . . . .	.91	1.18
equal to ammonia	1.10	1.18

REMARKS.—See also G—Johnston and Cameron's Elements of Agricultural Chemistry and Geology pages 1

The high value
of urine

Comparing the two analyses of urine, the Indian sample is not inferior to the English, and contains even more nitrogen. Urine contains the greater part of the potash of the total voidings; and, though I do not know the average quantity of urine yielded by cattle in India, it has been found in England that the total amount of nitrogen voided in the urine is from three to four times the quantity contained in the solid excrements. Seeing, therefore, that the urine of animals is richer in fertilising matters than the solid excrements, the loss involved by letting the urine go to waste must be very large. The answer generally given by cultivators when I asked them why no litter was used, was, "We have not enough fodder for our cattle. How shall we give them any litter?" And yet this is not a real answer, for, when I turned to the manure heap, I almost invariably found in it stalks and straw and leaves, all of which would have done to use as litter. These stalks were thrown in anyhow, so, too, the solid manure, but there was no attempt to make really good fermented manure out of it, or to let the dung, as it fermented, break down and decompose the stalks and straw and form a uniform mass. Each material was left to itself—the stalks to remain as they were, hard and decrepitated, the manure to get dry and to lose part of its value by exposure to the fierce sun during the hot season, or to the heavy rain in the wet season. Had these stalks, straw, etc., been put under the cattle, and been trampled down by them, it would have served to retain a not inconsiderable portion of the urine and would have made a more uniform material, and one which would have all rotted together afterward, and formed good farmyard manure. I do not say there is abundance of material for litter in all cases, but there is certainly a great deal that might be utilised. Leaves for instance, though collected for parching grain are neglected for litter. Again, if loose earth were sprinkled on the floor, to make up the deficiency of litter, and if this were to be periodically removed, much of the urine could be collected. Waste and coarse grass, shrubs, weeds, leaves, and rubbish of almost any kind would serve for the purpose, and I have often thought that if I could but spread the so called manure heap under the cattle again, I could double its value.

How manure
might be better
preserved

Where the cattle are better cared for, earth nut, gruelly cake, gram, and other foods having high manurial values are given to them frequently, but it is not borne in mind that with these more concentrated foods it is only about one tenth of the nitrogenous and mineral constituents of the foods that actually goes on to the body of the animal and repairs its waste, but that nearly nine-tenths remain in the solid and liquid droppings. It is the knowledge of this fact which has made English farmers careful to preserve the manure of cake fed cattle, and to keep their stock in covered yards instead of in the open.

Another frequent source of loss is, that the manure is often put, not in pits but in low heaps into which sun and rain can easily penetrate. Even when pits occur, they are often not much more than holes dug in the ground. If the bottom of the pit were well rammed down and the sides beaten firmly, or, where

possible, plastered over with clay and allowed to harden, much loss would be saved. The manure, once in the pit, ought to be turned over occasionally, even in India, so as to get the drier portions mixed with the moister, and to make the mass rot evenly together. When the rains come, there is no difficulty in covering the pits with earth, and if the manure were well made and less like the contents of a rubbish heap, less space would be taken up, and it would well repay to cover it with earth as suggested.

In Appendix F I have given an analysis of a sample of the liquid which was draining away from a manure heap at Bartchuhulla, Munjerabad, Mysore, and alongside I have put the analysis of a similar sample from a manure heap in England. These figures show that the drainings from the Indian manure heap are slightly richer, both in solid matters (including potash and phosphoric acid), than those in the English sample, and that they contain considerably more nitrogen. It is evident, therefore, that allowing the drainings to go to waste is productive of considerable loss in India, equally as it has been found to be the case in England.

147 One objection made to littering cattle is, that if they were kept in sheds with litter under them they would be pestered with ticks and flies, and that on this account cattle have to be occasionally tethered out in the open fields. Of course, when flies or ticks are particularly troublesome the cattle can be tethered outside if necessary, just the same, but it is simply the general principle that I am advocating, one which, if adopted, would result, I am sure, in much saving.

Another objection is the one which the English farmer made when covered yards were first introduced, viz., that the cattle would be unhealthy, however, in England this has not been found to be the case, and even as it is now in India cattle are often tied up in sheds, so I do not believe for a moment that the sprinkling of a small amount of litter, coarse grass, etc., supplemented by loose earth, would have any other effect than to make the sheds smell very much sweeter and cause a very important saving in manure. The popular idea in India, that cattle kept in sheds with litter put under them would fall ill, has been disproved by a 15 years' experience at the Saidapet Farm, Madras. Mr. Benson adds, from his own observations in the Presidency, that he has never heard of a case where any harm has resulted to the cattle from their being littered in sheds.

To my mind, a much more potent reason given for the non-adoption of the system is found in the answer which a *raiyat* gave me at Avenashi (Coimbatore). "It is hard enough to get sheds for ourselves," he said, "how shall we get them for our cattle?"

148 It is clear to me from what I have seen all over the country, and also from the writings of others, that manure is

1 gal. ga. from
manure heaps

Objections to
use oil for

Instances of
manure being
badly kept.

not well kept, and that there is great room for improvement in this particular.

(a) Punjab

A little beyond Multan I saw heaps of dung scattered over the fields; they had been left out in this way for over a month.

At Gujrat I noticed that upon the manure heaps was thrown a quantity of stalks and other material which would have done over and over again for litter. The greater part of the refuse is sold for the local trade of pottery-making, and the cultivators mainly depend for manure upon the coming of the silt from streams.

Mr E B Francis, of Ferozepore writes to me —

"The most important question in the improvement of our agriculture is "to improve the collection and storage of manure, which would at the same time be a measure of sanitation."

(b) North West Provinces

It is a frequent practice at Cawnpore to spread the manure out on the fields early, and to leave it in heaps until the rain comes. By doing this considerable loss is incurred, the manure ought to be spread out at once over the ground, and then the loss would not occur.

Mr Noens, in the Bareilly Settlement Report, says —

"There are two points on which our agriculturists need instruction — (1) growing green crops for cattle, (2) the proper management of their manure."

(c) Bengal

In Tirhoot, I saw near Bara heaps of manure lying in fields where they had been exposed for several weeks, and were fast losing their goodness.

The following extracts are taken from Bengal Reports —

Palamau — "Manure is kept on the bare ground, and a great deal is "wasted."

Burdwan — "Manure heaps are not well kept, and the urine is wasted. "Sometimes the heap is very carelessly managed and let to get too dry. No "litter is used, and the urine is allowed to sink into the mud floor of the "cowshed."

Dacca — "Instances are not wanting of heaps of rich fed cattle-manure "wasted."

(d) Madras

In only a few places in Madras did I find any attention paid to the preservation of manure. At Arcot no litter of any kind was used, and the urine, etc., was thrown, but it was seen used as litter. All this their urine was being wasted etc., had been thrown under soaked up. It is only right

to add here, that the *rayats* expressed themselves as very ready to receive instruction from anyone who would impart it to them.

At Shivali and Madara I saw no litter used, except in one instance.

Mr. Benson, writing of Kurnool, remarks on the bad way in which manure is kept.

Of Pallachi, in the Coimbatore district, Mr Nicholson says —

"The improvidence of the *rayat* is here exhibited in his reckless waste "of manure, whether animal or otherwise, which lies everywhere around the, "villages."

(e) Government Experimental Farms

Even at the Government Experimental Farms, although in some cases care was taken to store the manure better than the *rayats* did, I found there was still great room for improvement.

I must make an exception in the case of the Sandayet Farm, Madras, for, here, littering of cattle was carefully done. But at one of the Bombay Farms (Poona) the urine was allowed to trickle down an open drain, merely

cut in the earth, but not piped in any way and was supposed to flow on to a manure heap at the other side of the farm buildings, and situated a considerable distance off. The consequence was, that, so far as I could see, the manure was all lost except the state. The whole was (I judge) much more care had been taken, and better manure was produced, although the heap ought to have been better mixed up, and turned occasionally; the urine from the cattle was, however, allowed to mingle with the rain water from the roofs of the sheddings.

149. I believe that a great deal might be done by showing ^{The value of leaves.} the usefulness of leaves for litter. When I was in Mysore I saw leaves being used by coffee planters as litter in covered sheds for the making of cattle-manure, and it is quite feasible to extend this practice to many other parts. A slight sprinkling of fresh leaves on the surface every now and then is all that is necessary, whilst the lower layers get trodden and matted well together, forming capital manure. In Table XI, paragraph 146, I have given two analyses of leaves collected for this purpose, a large quantity having been mixed carefully and subdivided repeatedly to get average samples. A comparison of these analyses with that of farmyard manure (Table VII, paragraph 121) will show that there is more nitrogen and about the same amount of potash in the leaves as in the dung; the large proportion of vegetable (organic) matter must also exercise decided benefit. In one instance the amount of phosphate of lime is as much in the leaves as in the farmyard manure. The two analyses of leaves show considerable variation in the amount of mineral matter in each, this arising, doubtless, from different kinds of leaves being used. The relative values of different kinds of leaves for manurial purposes has still to be worked out. The leaves of the *Jack-fruit* tree (*Artocarpus integrifolia*) formed a large proportion of the sample marked II. The leaves analysed were those collected on Mr. R. H. Elliot's coffee estate in Mysore, so ~~very~~ similar to those he was in the habit of using for littering ~~his~~ bullocks. In some parts, for example, on the Malabar coast, it is the practice to collect and use leaves for manure.

150. If I have spoken of manure being badly kept, it is only right to mention a few instances where it is better looked after;— ^{Instances of manure being well preserved.}

The Saidapet Farm at Madras has already been spoken of as one instance.

On the eastern side of Rawal Pindi it is the practice to impregnate stable litter with urine before throwing it on the manure heap.

In Tinnevely, earth is often thrown over manure heaps before these are used for the cotton crop.

Littering of cattle by the coffee planters in Mysore has been referred to.

At Shiyali Mr. S. Sabanayagam Mudliar makes pits and clamps the manure closely together; in Gujarât (Bombay) manure is kept

in pits and not in heaps, at Nadiad Mr. Bechidas Viharidas Desai has a very large masonry pit in which manure is stored, and from which his tenants (those from whom he takes a share of the produce) are supplied. It was at Nadiad, too, that I witnessed perhaps the most careful method of conservation of manure to be found anywhere in India. At the time of my visit, the method was unfortunately threatened with abolition through the action of the Sanitary Authority. The practice in the town was, to keep the cattle in sheds within the compounds, the ground sloped away into one corner close at hand, where a pit was carefully dug and plastered; a channel was cut, leading from where the cows stood, and along this the urine was led into the pit (a distance of only a few yards). In this way the urine was soaked up and absorbed by the solid excrements, ashes and house sweepings. As the manure was dropped, it was covered over the surface. In this way the surface getting quickly hard and dry, there was little or no smell, nor anything objectionable.

Necessity of teaching the cultivator a better practice

151. The instances of manure being properly preserved are, however, very rare, and, broadly speaking, it may be said that the Native does not know the best way of making cattle manure, nor of preserving it when he has it. At the same time I fully believe that if he were shown how to do it, and were to be convinced that the practice is better than his present one, he would adopt it, and would litter his cattle

The work of Government Experimental Farms

A great opportunity is given to Government Experimental Farms to show how this can be done. If this matter were seriously taken up simultaneously at all Experimental Farms, and the cultivator were shown (as I am sure he would be) that better manure could be made, and better crops be grown as the result of saving the urine and storing the whole carefully, it would do far more good than expending money with artificial manures which are altogether beyond the reach of the cultivator.

Village sanitation

152. My enquiries into the subject of the better conservation of cattle-manure brought me into contact with points concerning village sanitation. To one of these as distinctly affecting agriculture, I must refer, more especially as the extended application of the sanitary rules contemplated. This I can best illustrate by the instance of Nadiad, in Gujarat (Bombay), to which I referred in paragraph 150. I there described the careful method by which the cultivators preserved the solid and liquid droppings of their cattle, keeping them, as well as the ashes, house-sweepings, etc., in

Hardship of the sanitary rules illustrated in the case of Nadiad

as, and into the oval of within is was, there being closely-packed heaps of well rotted manure within

the compounds, the urine being absorbed before it had had time to decompose, I found, lying along the roadsides, or in the lanes, or by the hedge sides, numerous small loosely-packed unfermented heaps of fresh manure and rubbish, on which the rain beat down, washing out the goodness, and rendering it cold and unfermentable. Women might be seen carrying out in baskets on their heads mere handfuls of manure, they having frequently to go a considerable distance several times a day. Within the compounds it was even worse, for the cattle being still kept there, the urine, now no longer absorbed nor allowed to collect in the pit, flowed over the ground, and, mingling with the rain water, ran into the open street and along the sides of it, producing in its decomposition, wherever it dried up, a powerful smell which was the very reverse of sanitary. The effect of the so called remedy was to produce a state of things infinitely worse than before. But it is the *Patidars* who particularly to refer. The people are bitterly of having to convey the manure out of the town every day, they say that it was against the *Patidars'* feelings to let their women carry the manure out themselves and so they had to pay for hired labourers to do it, that, when the heaps were put out, they were constantly liable to be stolen, that the manure was not well made, the urine was lost, and the heap much spoilt by the rain, so that it never rotted properly. To test them, I asked to see what they called *well-made* manure, and soon I was shown some well-rotted, nearly black, rich manure, obtained, no doubt, from a manure pit which had not yet been removed. The quality of this was such as to convince me that these people, at least knew what good manure was and how to make it. In a part like this, where a magnificent cultivation was in a very great measure the result of the careful conservation of manure, it seemed to me a great mistake that the *Patidars* should be allowed to produce a state of things so unsanitary, light, and one so absurd to take such measures while still allowing cattle to remain within the compounds, the urine polluting the streets and the manure heaps making the roadsides objectionable. Either the *Patidars* ought to be allowed to follow their economical and unobjectionable practice, or the cattle ought not to be allowed to stand at all within the compounds. The reason stated for the action of the authorities was, that human ordure was also put on the heaps in the pits, and a rule was made to compel the people to resort to the latrines outside the village. Even if a little ordure did so go, it was of small consequence and showed a sense of economy, and, besides, whatever sanitary rules may be made, I do not believe that they will ever succeed in compelling the women to go out at night into the fields where the latrines are. The people of Nadiad are very healthy, and epidemics are much more frequent in the towns than in these rural districts. It was pointed out also that, while the presence of the manure heaps was considered by the sanitary authorities to be highly dangerous, it was the practice everywhere to plaster the walls and floors of houses with cow-dung, and yet no

one got ill from it. Fully one-third of the entire population of Nadiad were cultivators.*

When I was in the Central Provinces I found that similar rules were being enforced on account of the fear of cholera. Nevertheless, the cattle were still allowed to be tied up at the houses, although the manure had to be carried outside the villages. Here, however, the manure heaps were not kept with the same care as was exercised at Nadiad.

Closing over of
drinking wells

I might mention in this connection the desirability of covering over, both in towns and in villages, all wells which are used solely for drinking purposes.

In view of the contemplated sanitary rules, I have gone into as I think that attention should

Wider distri-
but an of
dwelling and
wells over the
land advisable

153 There is one way in which the manure supply, both of cattle-manure and of night-soil, could be used to better advantage, but it is hardly a feasible plan now, I fear. I have remarked upon the appearance of a North-West village, the habitations crowded together, the wells and the best cultivation and the most highly manured land lying close around the village site. This, doubtless, has arisen out of the experience of the past, owing to the necessity of combination for self-protection against the raids of marauders. Undoubtedly, however, if the habitations could now be more scattered over the land, and not be huddled together on one spot, the manure would be more widely distributed also, and probably not be so much wasted, the wells also would be dotted about and not clustered together. Captain Chipman told me that when he came into possession of his property at Shripore, in Oudh, one of the first things he did was to dig wells, not around the village site but distributed over different parts of the estate. The consequence was, that when new settlers came, they fixed their dwellings where the wells were, and thus the manure from their cattle was distributed over a wider area and was not concentrated around the dwellings, leaving the outlying parts unmanured.

Could the habitations be more scattered, and the wells, too, the land would certainly be better manured.

* Since writing the above I have heard that the Collector of Nadiad has recommended that the inhabitants be allowed to keep their manure heaps in the town as before provided that each man makes a pit with brick sides, and that the manure be removed to the fields as soon as the pit is full.

CONCLUSIONS

CONCIS-
SIONS.

154 Whilst a few soils, such as those of salt-renewed tracts, the black cotton-soil, and newly-reclaimed or virgin land, may not require manure, it may be said of the greater part of India that the necessity for using manure is enormous, and the supply of it is notoriously inadequate. Water and manure are interdependent, and, just as the former has been and is still being provided for, so must attention be given to the supply of manure. These two factors, water and manure, constitute the *king's* great needs, and in their supply consists, very largely, the Improvement of Indian agriculture. It has been shown in this chapter that, under existing circumstances, the manurial supplies in use are not sufficient to replace the crops that are taken off the land, further, that the increasing tendency to export both crops and manures must cause a deterioration of the soil.

In considering the various sources of manure, it has been pointed out that, with the exception of cattle manure, the amount and use of them is most limited.

Practically, therefore, everything centres in cattle-manure, and the question of how to use it to better advantage.

There are two main causes which prevent manure from being properly utilised. The first is, that it is burnt as fuel because there is a deficient supply of wood; the second is, that it is not properly made, inasmuch as the urine is altogether wasted, and the manure is badly kept. The second of these two causes may be gradually removed by the spread of agricultural instruction, and by the example of Government Farms and Estates. The first cause, however, is one that cannot be removed except by the taking of bold measures by Government, such as those taken in introducing canals and in carrying them throughout the country. Government cannot directly provide manure for the land, but what they can do is, to provide wood to take the place of cow-dung as fuel, and so to liberate the latter for its proper use upon the land. In short, Government must now turn to supplying wood for agricultural purposes just as they have supplied and are supplying water.

The situation has been sketched out in Chapter V (paragraph 51), when dealing with the question of exhaustion of soil. A rapidly-increasing population creates a greater demand for food.

soil and upon the food crops which it bears. Could the produce be increased even by one or two bushels per acre, as Sir James Caird estimates, the difficulty of population would be met, but without more manure the soil cannot do it, and the export both of crops and manures is *removing* instead of *adding* to its fertility. Meantime the increase of water facilities, through Government aid, calls for the use of more manure, but the latter is for the greater part wasted because the supply of wood for use as fuel is inadequate. What is the position of Government in the matter? For practical purposes Government are in the place of a landlord, and as such it is their duty to look after their property, and to see that it is kept up, and not be allowed to become impoverished. The present system is one of gradual soil-exhaustion, which must end in a decline, slow it may be, but still a decline of fertility and of productive power. It behoves Government therefore, for their own sake, to take this matter into serious consideration, and, while there is yet time, to push forward active steps for preventing the decline in the value of their property. Unless this situation be faced, Government must be distinctly prepared to see the land bring in a diminished revenue, and to find the people less able to live upon the land. Nor must the bearing upon the question of Famine be ignored.

Mr Nicholson has pointed out that in times of serious drouth manured land is able to yield at least something, or even a moderate crop, whilst unmanured land may produce absolutely nothing. The existence of some crop, instead of total failure may make all the difference between famine and no famine.

Lastly, there is the consideration that if more manure be supplied, the land will become more fertile, and be capable of returning an increased revenue to the State. It therefore becomes, I maintain, the duty of Government, both to themselves and to the people, to supply manure to the land. In this, now, must rest practically the Improvement of agriculture. Of what benefit will it be to cover the country with Agricultural Schools, and to teach better methods unless the one great want of the cultivator be met, viz, more Manure? Of what use will it be to demonstrate at Experimental Farms the value of manure, and how to preserve it, when the cultivator has to burn it because he has nothing else for fuel?

The one way in which alone this question of paramount importance can be met is by supplying more Wood, and thus setting

free the manure for use on the land. I shall deal in the next chapter with the exact way in which wood might be supplied, but I may say here that it is in this connection mainly that I advocate the establishment of "Fuel and Fodder Reserves."

To adopt the method followed in my earlier chapters, of summarising possible improvements in agriculture—it has been seen that considerable differences exist in agricultural practice according as the facilities for manure supply are greater or less. Improvement in agriculture will take place through the modification of these differences. This cannot be effected directly by the people to any great extent, although, here and there, as with the *Kachhi* cultivation, example will tell. Government will be able to assist in the work by the spread of Agricultural Education. Education will have a powerful influence in breaking down prejudice, and, by it, the better practices and their advantages will be made known.

But the work of Government does not stop here, *positive* measures, too, must be taken. First and foremost, Government must supply wood for agricultural purposes, to take the place of the cow-dung at present burnt. Then, Agricultural Departments must, by means of an organised system of *agricultural enquiry*, ascertain the manurial facilities and needs of each part of the country, they must acquaint themselves with the practice of the best parts, and transfer it, when possible, to others, they must ascertain and demonstrate at Experimental Farms the value of various manures, and, in especial, the benefit of littering cattle and the better preservation of manure. It is evident that in this work advantage will have to be taken, not only of a knowledge of indigenous practice, but also of Western science and experience. In this connection I would urge, as most desirable, the appointment of an Agricultural Chemist, who may render much assistance in utilising existing manurial sources, in demonstrating their use and value, in possibly discovering new manurial resources, and in solving various questions bearing on the relation of soils, crops, and manures.

Conclusions.

RECOMMENDATIONS

RECOMMENDATIONS.

155. I advocate,—

The establishment of "Fuel and Fodder Reserves," for the primary purpose of supplying wood to take the place of cow-dung as fuel.

The inauguration of a system of Agricultural Enquiry, to ascertain the manurial facilities and requirements of each part of the country.

The spread of Agricultural Education, to assist in teaching the value of better practices, and to break down prejudice.

The employment of Experimental Farms, for the purpose of showing how manurial resources can be best used and conserved, and for demonstrating the value of, and extending, the better practices of other parts.

The employment of an Agricultural Chemist, to assist in utilising existing manurial resources to best purpose, in discovering fresh ones, and in the solution of agricultural problems

CHAPTER VIII.

CHAPTER
VIII

WOOD

Wood,

156 From the last chapter, in which the manual resources of India were considered, I pass now to discuss the wood supply of the country, and how it may be increased primarily with the view of setting free more manure for the land by the substitution of wood for cow-dung as fuel.

In order to understand how agricultural ends in the matter of wood supply are to be best served, it is necessary to briefly review the policy which, in the early days of the Forest Department, was adopted in regard to forests and other supplies of wood, and also the changes which have been called for in more recent times.

157. At the time of its creation, about 1866, the Forest Department found the forests of the country fast disappearing before the spread of cultivation, and before the reckless destruction carried on by the people. Agricultural resources were vanishing, and the climate was, not improbably, being affected injuriously. Not too soon did the Forest Department step in to prevent the entire deforestation of the country, which would most certainly have taken place. As the demand for cultivation spread, so would the forests have disappeared before the plough, had not a strong hand been interposed to save what was still remaining.

Early policy of
Forest
Administration.

The people, left to themselves have never been able to manage forests properly, nor to understand how forests may be conserved and utilised to the best advantage. Their practice had been simply to cut and clear the forest to make room for cultivation, and, as soon as the virgin soil was spent, they pushed on, broke up fresh land and cleared more forest. And thus, if allowed, they would still do, thinking only of the immediate present, and not of the future.

But the Forest Department, by its intervention, has stopped in a great measure the work of destruction and has not only brought in a large, and ensured a continuous, revenue to Government, but it has laid the foundations of a system which, if properly directed, may be made to conduce greatly to the agricultural prosperity of India. But when it began its work its chief duties were the preservation and development of large timber for us, such as the teak forests of Lower Burma, the *adi* forests of Gouth, and the *drolar* forests of the Himalayas, or the forests of the Western Ghats. Its objects were in no sense agricultural, and its success was gauged mainly by fiscal considerations, the Department was to be a revenue paying one. Indeed, we may go so far as to say that its interests were opposed to agriculture, and its intent was rather to exclude agriculture than to admit it to participation.

Good work done
by Forest
Department

Its success
measured by
Forest Revenue
received.

in the benefits. The chief reason for this was, that the admission of grazing into the forests would have destroyed the young seedlings, and have rendered the maintenance of the forests by natural reproduction impossible. So far as the original design went, the Forest Department deserves full recognition of the admirable work which it has done in saving to the country the forests now under its care, but which, if left to the people, would have been ruthlessly destroyed.

Causes of a
change of policy.

158. At that time, however, these large timber forests were not in contact with important tracts of cultivation, but were, for the most part, situated on hills and mountain ranges only occasionally bordering on cultivation, and that of a sparse and backward kind, often carried on by half-wild tribes. As the population increased, and the pressure on the land called for extension of the cultivated area, so the latter spread to the borders of the forests. Again, of recent years, there has been a feeling that the forests and other wooded tracts ought to be made to serve the interests of agriculture more directly than they have done in the past, and that areas should be reserved and fresh ones be created in the midst of the cultivated land, and not merely on hills and mountain ranges. The Governments of India, Bombay, and Madras have been urging their respective Forest Departments in this direction, and have endeavoured to extend the influence of the forests from the remoter hills to the cultivated plains. In this way the policy of the Forest Department has been undergoing a change, in order to meet the altered conditions of agriculture. The old traditions which animated its officers, viz., that the sole aims of a forester were to grow big timber and to show a large revenue, are wearing off, and, whereas considerable prejudice existed in the past against the Department, by reason of its being opposed to agriculture, a feeling is now growing, among the more enlightened of its officers at least, that one great object should be to directly serve agricultural interests. It is this altered policy that I wish to support, and to show, if possible, the need of giving fuller scope to the usefulness of the Department.

Agricultural
requirements in
respect of wood

159. The requirements of the agriculturist in respect of wood are, small timber for house-building, wood for making implements, and firewood, the last-named principally to take the place of the cow-dung which, though the most valuable manure at the *raiyat's* disposal, is, nevertheless, generally burnt as fuel in default of wood.

The paramount
importance of
supplying wood
to replace dung
as fuel

160. In the last chapter, after reviewing the various sources of manure supply, we saw that they were very limited in number, and that the only material available in any quantity was the ordinary cattle-dung. Further, we found that, wherever wood was sufficiently abundant, dung was used for the land and it was not burnt, but that where wood was deficient, manure was burnt in the absence of any other source of fuel,

and that the land was thus deprived of it. The dependence of the soil for its fertility upon the supply of water and of manure was also insisted. The conclusion was, accordingly, drawn that the supply of wood to serve as fuel forms one of the most important factors in maintaining the fertility of the soil, or, in other words, the prosperity of agriculture. I can hardly put this too strongly, for it is *the one* practical measure on which I place the most importance, it is that which calls for the most urgent attention, and from which the greatest benefits may be expected to follow. I make, in my Report, other recommendations and suggestions, it is true, but I consider them *minor* ones compared with this. Let us once more review the position. A country exporting manures as well as crops, not utilising even the night-soil, and then burning the cattle dung because fuel is scarce, an ever increasing population, and a greater demand on the land to supply more and larger crops, these latter depending on more manure being available. What more ready plan than to supply wood as fuel in order to save the manure for the land? In the substitution of wood for cow-dung no question of *caste* prejudice is involved, such as is the case in the use of bones or of night-soil. It is a measure which the people would adopt, and have adapted, on their own account, wherever it has been possible. Further, the improvement thus to be effected is one which proceeds upon the right lines, *viz*, the improvement of Indian Agriculture from *within* rather than from *without*.

I therefore do not hesitate to say that, just as Government foresaw the difficulties of the people in supplying themselves with water, and so provided it for them, so must attention be now turned to the difficulties of the people in the matter of fuel, and, seeing how impossible it is for them to provide it for themselves, Government must do this for them too. It is not in the interests of the people alone that I would urge this, for, having fully discussed all other ways of increasing the manure supply, it is clear that this is *the one way* in which it can be effected, and, if not effected, sooner or later the land must fall off in productive power, and the revenue derived therefrom by the State must decline too. Accordingly, I regard the provision of fuel as the most potent means of maintaining prosperity, not alone to the cultivators, but to the State itself, and as a measure which the latter, *in its own interests*, should take up immediately. If wood could be made to take the place of dung for fuel we should soon come to realise that more wood means more manure, that more manure means more crops, and more crops an increasing revenue to the State, whilst, to the cultivator, it implies more fodder, better cattle, and more manure again to ensure the future fertility of the soil.

The importance
of this to
Government

161. I do not take to myself credit for more than emphasising what others have already pointed out on this subject. As much as 17 years ago Mr R. H. Elliot, writing in the "Times," urged the necessity of "Fuel Reserves" for India, and much that he then said has since proved to be true. The same views have

Previous
expressions of
this view

been urged by others, but there is call now for more definite action than there has been in the past. What has been done so far, whilst not without benefit to agriculture, has, to my mind, taken mainly the form of supplying wood for the requirements of large towns and railways. Although agriculture has been indirectly helped by the smaller amount of dung burnt in consequence, yet I think that hardly enough importance has been attached to the bearing of the wood supply upon the fertility of the soil, and to the need of supplying firewood to villages as well as to towns.

Other
advantages of
tree growing
influence on
climate

162 The influence of an extended growth of wood upon the climate has been fully dealt with in paragraph 38 of Chapter IV, and has been referred to as affording a possible, though perhaps only local, amelioration of the severities of climate.

Protect on from
winds and sun

There is another feature about tree growing which must not be forgotten, viz., the shelter and protection afforded from the burning sun, and also from the violent winds. Mr. Nicholson points out that many tracts in the Coimbatore district are exposed to severe winds. He says—

Dharapuram District—"Hedges and belts of trees would be peculiarly useful in this wind swept tract."

Udamalpet—"It is the most open taluk in the district, having few hedges and very few trees, hence the winds of the south west monsoon are severely felt."

Many parts of Mysore suffer greatly from damage by wind. On the North-West frontier the presence of trees is indispensable to the growing of grass.

Supply of leaves

The advantages of tree growing in connection with the supply of leaves for litter and fur manure have been spoken of in Chapter VII (see paragraph 149), and to this may be added the provision of food afforded both to men and cattle in time of famine, if suitable kinds of trees be grown.

Famine food

What Govern-
ments have al-
ready done in
this direction

163. Whilst laying particular stress, as I have done, on the need for an extended wood supply, and mainly for the purpose of providing fuel, it would be wrong to ignore what the respective Governments of India, Bombay, and Madras have done, or, at least, have urged on their Forest Departments the necessity for doing. Without going into particulars, I would indicate the general lines that have been taken.

Sir D Brandis'
work

It was Dr. (subsequently Sir Dietrich) Brandis, the real founder of the existing Imperial Forest Department, who gave the great impulse to the growth of what may be termed "Agricultural Forest." It was he who clearly saw the line which the Forest policy of the future would have to take, and who did his best to guide it in this direction. Already in 1873, at his suggestion, tracts had been taken up in Ajmere-Merwara, a little territory under direct Imperial control, and thus available for the purpose. This will be explained more in detail later, but it may be said here that the results were very satisfactory, and Sir D. Brandis wrote—

"It may be pointed out that in all except the most arid tracts or where denudation is complete and of long standing, mere protection aided by

"sowing and planting in suitable places, will gradually clothe grounds with trees and shrubs."

Sir D. Brandis, at the close of his Indian career, went himself to Madras to assist the Madras Government in framing their policy of "Agricultural Forests," and largely to his efforts it is due that in Madras so much has been done to make the Forest Department serve agricultural interests.

The Famine Commissioners showed that they were alive to the way in which the forests might assist agriculture. They said in their Report —

Recommendations of Famine Commission

"So far as any immediate advantage is to be sought from the extension of forest in respect to protection against drought it will, in our opinion, be mainly in the direction of the judicious enclosure and protection of tracts . . . from which improved and more certain pasture may be secured for the cattle of the vicinity, a supply of fire-wood secured which may lead to a more general utilisation of animal manure for agriculture, and a possible addition made to the power of the subsoil to retain its moisture, and to the prospect of maintaining the supply of water in the wells."

The Government of India, in following up the recommendations of the Famine Commission, issued, in March 1883, a Resolution calling attention to the growing decrease in the area of grazing land and wooded tracts in many parts, notably the Panjab, the North-West Provinces, and the Central Provinces, and to the damage done through excessive grazing. They quoted numerous cases, such as Banda, where, in the famine of 1878-79, grazing areas had been instrumental in saving thousands of cattle, and other instances, such as Jhansi and Rohtak, in which thousands had perished for lack of these areas. They asked, therefore, the attention of Provincial Agricultural Departments to this question, and the co-operation of the Forest Department. It was suggested that enquiry should be made by district officers, with a view of ascertaining how far cattle needed protection, and what lands, either Government property or else purchasable at reasonable rates, were available for the formation of what were thenceforth to be termed "Fuel and Fodder Reserves."

Government of India's Resolution of March 1883

It was recommended that the purchase of land should be effected, provided the price came within a limit of Rs. 20,000 for 10 square miles. The actual management of the "Reserves" was intended to be in the hands of the Forest Department.

Enquiries were next made, at Government suggestion, as to whether suitable spots for "Fuel and Fodder Reserves" existed along canal banks and lines of railway.

As the result of the enquiries made, it was ascertained that in the Doab (North-West Provinces) saline land (*usar*) could be

Action taken in North West Provinces and Panjab

obtained in abundance, and also a certain amount of *ravine* land, both of which would pay for growing trees and grass upon. Ravine lands at Etawah and at Jhansi were subsequently taken up, and canal plantations have been established at Cawnpore, Agra, Rurki, Delhi, and other parts of the North-West Provinces and the Punjab. Other plantations, such as those of Chauga Manga, and Shahdara, near Lahore, had been previously created by the Forest Department.

Mention was made just now also of the "reserves" established at Ajmere-Merwara at the instigation of Sir D. Brandis.

A lion in
Madras

But it is in Madras that more has been done than anywhere else to assist agriculture by means of the forests. One great reason for this is, that in this Presidency the waste land is the property of Government, and they can therefore dispose of it as they like. This is also the case in Bombay, and wherever no permanent settlement of the land exists. The exceptional circumstance that Ajmere-Merwara was under the direct control of the Government of India enabled land similarly to be taken up there for the purpose of forming "reserves." Again, in Madras, cultivated land is more or less mixed up with undulating wood-producing country, and thus field and forest come in close proximity, presenting a great contrast to the vast level plain which includes the Punjab, North-West Provinces, and Bengal.

The large
timber-producing
forests

164 I propose now to deal in succession with the different ways in which at present the supply of wood is maintained, and then to consider in what directions extension for agricultural ends is most needed.

First of all come the large *timber-producing forests*. Everyone must recognise the necessity of having these, they supply Europe with teak, for example, and are requisite for all building purposes, and for providing railway sleepers, furniture, etc. As we have seen, they are for the most part still removed from the general area of cultivation, and it is mostly on the hills and mountain ranges that they are found. They are clearly demarcated and defined as being forests for the *primary purpose of supplying large timber*, and should, I think, be rightly treated as such.

In them the main end should be kept in view, and every means be used to grow as fine and as large timber as may be required. From these forests grazing must be excluded entirely, if the forest be worked on the *jardina* system (that according to which trees of all ages, from seedlings to mature trees, are mixed up together, singly or in groups, everywhere over the whole area, the fellings being similarly located at short intervals wherever a suitable tree may happen to be). The object being to encourage natural reproduction and re-stocking, grazing would do great damage, inasmuch as the seedlings would speedily be nibbled off or trampled down. If the forest be worked in blocks, trees of like age being classed

into separate groups, it would perhaps be possible, without direct damage to the forest, to admit grazing into particular blocks at certain times. In any case, in time of drought these forests would be the means of keeping alive many of the cattle of the country. But, beyond this exceptional event, in forests of this class I should like the forest officer to have full liberty and every facility for growing large timber independently of any minor considerations; also, I think that he should be allowed to strictly enforce rules for preventing forest fires and for excluding grazing, etc., as well as all others that are necessary to the attainment of his main purpose.

It is, in short, impossible to have on the same area; the most that there two is, to provide, for the immediate of small wood and firewood obtained and to serve as a refuge for cattle in time of drought and famine.

Of this nature are the Coorg forests, which I visited under the guidance of Mr. H. C. Hill, Officiating Inspector General of Forests. They are at a distance from, and not in the midst of or near cultivation, and they could not now be brought to benefit directly the actual cultivators of populated villages at a distance. Around them is only a scattered agriculture and a meagre population. Here, I should say, are forests which by their position are best adapted for *timber-growing* purposes, and for such purposes they should be kept. They are too far off to supply the cultivator with firewood at a rate which he could afford to pay, and which would at the same time be remunerative to the Forest Department; whilst, to the cultivator, even were there any considerable agricultural population, the cost of carting would be prohibitive. It may, however, pay quite well to remove large logs, such as contractors or railway companies would buy. I am obliged, therefore, to look on these forests as likely to do but little to increase the supply of manure available for the land through the substitution of wood for cow-dung as fuel.

Whilst advocating the closer attention of the Forest Department to agricultural ends, and commending the step taken in 1884, which brought the Department under the Imperial Department of Agriculture, I have no wish to urge interference with the necessary and legitimate purposes which the large timber-growing forests serve for the good of the country. Large timber is, and always will be, required, and to make the supply a means of obtaining a large revenue is a very proper end, where, as I

close these forests altogether to grazing, or at least only to open certain blocks at a time, and to enforce stringently the rules which exist in regard to the prevention of forest fires. I have myself seen, over and over again, during my tour through the Coorg forests, instances of the damage done by forest fires, how that seedlings are killed and the entire natural reproduction, so

- Necessity of maintaining
- Forest rules as to grazing and fires

essential in a timber forest, is completely stopped. I can quite understand, too, the damage that will be done in a forest where reproduction is going on, either on account of cattle trampling down the seedlings, or by goats pulling down the branches and young trees bodily, or by goats and sheep nibbling off the young shoots. Goats, in particular, must have no place in a forest of this kind

Much has been said by certain writers in favour of the annual setting on fire of the forest grass, in order to get a fresh growth of herbage. The occasional clearing of the coarse dried grass by fire may result in the growth of a temporary crop of fresh grass to feed cattle for a month or so, but it simply means ruination to the forest, and the infliction of damage from which the forest will not for many a year recover. I have, therefore, no sympathy whatever with those who have maintained that it is a good thing to have an annual burning of the forest grass, or that the forests ought to be thrown open to unrestricted grazing. But I wish to make it clear that I am here speaking of forests which are essentially, by situation and natural conditions, *timber-producing forests*

Classification of
forests

165 The Forest Department recognises three classes of forests (1) "Reserved Forests," or those which, being the property of Government, or over which they have proprietary rights, have been set aside and constituted "Reserved Forests," (2) "Protected Forests," or those which, though the property of Government, or over which Government have proprietary rights, have not been included in a "reserved forest," in these Government may declare any class of tree reserved, or close any part for a term not exceeding 20 years, (3) all other forest lands are termed "Unclassed forests"

"Protected
Forests

166 Of "Protected Forests" I need say little more than that I think it would have been very much better to have made them all "Reserved Forests." The retaining of certain rights by Government, and allowing the people to do otherwise as they like is not conducive to the forest serving the best purposes

In many cases, notably the Punjab, the creation of "protected" forests has arisen, I believe mainly from the fact that the Local Government have not had the courage to extend full protection to land which ought really to have been "reserved" forest. A partial protection only has been extended to them, the Local Government fearing to cause friction with the people. In view of the important issues of forest preservation, the reckless use of the forests by the people when uncontrolled, and the general unsatisfactoriness of the working of "protected" forests, it would, I think, have been much better to have taken the bold step at the outset. In the case of any land that is reserved, exclusion from it may be necessary for a time at first, but before long the benefit of doing this will be apparent, and even in the first year a quantity of grass will probably be available for cutting as fodder

167. Among "Reserved Forests" are included the timber-growing forests which I have referred to in paragraph 164. I now intend to deal with those "reserved forests" which are near the cultivated areas, and which can be made to serve agricultural ends. The action taken by the respective Governments of India, Bombay, and Malras in extending the influence of the forests from the hills to the cultivated plains was, undoubtedly, a good one. But, from one cause and another, it has come about that, with some exceptions, the advantages of "reserved forests" have hardly been brought home to the agricultural population, and too often the latter have been inclined to regard the reservation of a forest as their exclusion from it, rather than as the means of providing a benefit for them.

"Reserved Forests near cultivation."

The advantages not fully realised by the people

It is necessary to look briefly at the causes which have brought this about. Undoubtedly in the past there has been a tendency on the part of the Forest Department to grow large timber only, and to reap a large revenue by doing this. We have seen, in paragraph 157, how this naturally came about, and that it was the result of the duties with which the Department was charged at the outset. But the traditions have not altogether passed away even now, and there is still need of reminding the Department, as Sir D. Brandis did in 1883, that the growing of big timber is not the only, and often, indeed, may not be the main, object of a forester's existence.

The reasons for this.

The traditions of the Forest Department.

Sir D. Brandis wrote in 1883 —

"It must now be distinctly recognised that not only does the provision of timber and firewood come within the legitimate scope of forest administration in India but one of its most important duties will in future be to increase the supply of cattle fodder particularly during seasons of drought in the drier districts."

There have been, undoubtedly, considerable difficulties in the way of the Forest Department, and where, as in the case of Ajmere Merwara, there has been no hindrance to procuring land, the Department has shown its readiness to minister to the more agricultural needs as well as to the growing of timber.

Difficulties in procuring land

Nevertheless there is, I think, a great deal more that can be done, and what is chiefly needed is, to extend the action taken by the Madras Government.

I should, in justice, say here that among the officers of the Forest Department there are many who recognise the importance of the objects to which Sir D. Brandis refers, and who carry them out as far as they can. Some such men I met during my tours.

168. What prevents extended action is not any check from the Government of India, nor yet from the Forest Department, but it is a financial check, and one which accordingly prevents Local Governments from taking action. The Forest Department is practically called upon to show a large revenue, and is naturally proud of the profit it makes. At the same time it is a notoriously undermanned Department, but is unable to increase its staff.

Difficulties in the way of extended action in an agricultural district.
The financial check

materially (as would be necessary were the more agricultural purposes closely followed), unless by showing a still larger surplus to meet the expense of additional officers. So it has come about that, in the majority of cases, the officers have turned their efforts mainly to producing large timber wherever they could, even though the circumstances of the "reserved forests" would, in the wider sense of the good of the country as a whole, have often adapted them better to other purposes than timber growing.

* Reserved
Forests often
better adapted to
other purposes
than timber-
growing

169 It is by no means the case that timber-growing will always be the purpose to which the forest is best suited naturally, or the most desirable one when all considerations are taken into account. Areas have been taken up in the past, and the attempt has been made to grow on them timber for sale, whereas these areas were never fitted for such a purpose, but only for growing scrub-jungle and for providing grazing. There are many such instances in the Madras Presidency. If the Forest Department is told to conserve timber it will do it, and wherever it sees a chance. What must come to be understood is, that forests may be so situated or naturally so adapted that timber growing may not always be the main end to be sought, but that what the forester is accustomed to regard as "necessaries," such as small timber, firewood, grass, etc., should, in many cases, be the main consideration, and that for which the forest should be worked. In some of the Bombay forests, for example, the supply of twigs and leaves for the *ráb* system of making seed beds (see Chapter VII, paragraph 131) may be the most useful aid to agriculture, and the growing of trees that may be pollarded would do much more good than supplying timber. At Mahim (Bombay) and Hospet (Madras) I saw cultivators lopping the trees around their own fields, the twigs and leaves being utilised either for *ráb* or else directly as manure for rice fields. Nor were the trees ruthlessly destroyed, for they were only lopped once in four years. Similarly, some trees are most usefully grown for pollarding, the shoots being used as props for plantains or *betel* vine. At Mahim I counted over 50 new shoots on a pollarded *Shendi* (*Hibiscus*) tree, and I was told that the number went sometimes up to 100. The shoots take three years to grow to a sufficient size, and the trees live for 40 years. I could not help thinking it was much better for the trees to thus yield a triennial supply of shoots for 40 years, than that they should be left alone all the time in order to afford at the close of it one single log of timber.

Est

Pollarding and
lopping of trees

Where such is the case, and seeing that in wet regions the *ráb* system has been proved to be the best for rice cultivation, it would frequently be very legitimate for the Forest Department to work for the supply of *ráb* instead of for timber. The Forest Department have, in some instances, tried to undertake the provision of *ráb*, but the difficulty has been that they feel compelled to cut it according to rule, and then to stack and keep it, whereas the cultivators must have it fresh, and just when they want it, as well as at a not expensive rate.

170 In demarcating a "reserved forest" it is the practice to ascertain rights, and provide for the continuance of rights which are found to be already existing over such areas. But more than this is required. It is not enough to satisfy existing rights, or to provide for the wants of the people immediately around the reserved area, and then to say, "Having done this, we will now grow our timber." What I maintain is, that, having marked off the most suitable and more distant areas for timber-growing, the "reserved forests" which are nearer cultivation should be worked more in the interests of the people than has been the case in the past, and that the *first* consideration, and not the *last*, should be how the wants of the agricultural community generally (who are not fortunate enough to have acquired any rights) can be best met, and how the benefits which the forest reservation confers may be extended to as wide an area as possible. To this there are limits of distance beyond which firewood, etc., cannot be profitably carted, but my contention is, that the object to be kept in view should be to see *how large a number* of the cultivating villages *can* be provided for, not *how few must* have their actual rights supplied. When this is done, I have not a word to say against the remainder of the forest being utilised for timber growing, for sale of fuel to towns, for letting out to graziers, etc., whichever be possible and most remunerative; but these must come *after*, and not *before*, the agricultural needs of the country.

The provision for existing rights

171 It is right that I should here make an exception in favour of what has been done in Ajmere-Merwara. The reserves here, which I had the pleasure of visiting under Mr H C Hill's guidance, quite meet the ends which they should fulfil. No attempt is made to grow large timber (the soil, indeed, is quite unsuited to it), but large quantities of small wood and of firewood are produced, and a considerable amount of grass is cut for fodder, whilst, even during my visit, the reserves had, in a time of drought, been the means of saving a number of cattle belonging to the surrounding villages.

Exception in favour of Ajmere-Merwara.

I am told that similar reserves may be found in different districts of the Punjab.

If the example of Ajmere-Merwara were to be followed extensively, much good would certainly result, but, as it is, there is room for improvement, and my remarks made above hold good, I believe in general.

172 As to firewood, it is quite true as forest officers have pointed out to me, that the price of firewood must be regulated by the demand and that firewood cannot be sold at one rate to a town and at another to the cultivator, or else the latter will at once resell his purchase at a profit. But, what I think might well be adopted is the system by which the inhabitants of certain defined areas around a "reserved forest" might be allowed, on payment of a certain yearly sum, to take out an annual license to remove what wood they require for building, implements, and firewood, as also fodder, etc., provided these be for their domestic

System of annual license in reserved forests

use only, and not for sale; also to graze (when grazing can be provided) all cattle of which they are the *bona fide* owners. This would get rid of any difficulty as regards the price of firewood, and, inasmuch as the licenses would specify the particular blocks where the permission could be exercised, and would be liable to be cancelled if the restrictions were exceeded, the control would be with the forest officer, who would determine the areas to be thus set off.

The only difficulty would be in the case of those who hold rights of grazing, of removing firewood, etc., and who would hardly be willing to pay an annual sum when before they had been free. This would, however, not apply everywhere, and where it did, the rights would have to be defined, just as is done at present in the case of "reserved forests."

The Forest
Department
undermanned

173 I have spoken of the need of a larger staff of better-trained men in the Forest Department to carry out the working of forests in an agricultural direction. As the forests come more in contact with agriculture, so will there be need of greater supervision and more official protection against fire and against unauthorised grazing, etc. To take an example, in the Coorg forests there is only one European professional officer over an area consisting of 248 square miles of "reserved" forests, and 601 square miles of "protected" forests.

The Forest
Department
sometimes tries
or is expected
to perform
impossible tasks

174. But the Forest Department is sometimes called upon, or else attempts, to perform impossibilities. When the need for serving agricultural ends has been impressed upon them, the officers have frequently been expected to produce out of the same forest large, medium sized, and small timber, firewood, leaves, *rab* material, and grazing all at once. In Bombay the Forest Department has decided that these varied wants can best be met by a 40 years' rotation. This means that *rab*, for example, could in any one year be only taken off one fortieth of the area, a very insufficient amount in many cases. It is quite clear that cutting for *rab* must be done near cultivation, and that there must be regular working plans drawn up for it, the people being allowed to cut the material themselves over allotted areas, worked, say, on a three or four years' rotation, and payment to be by levy on the rice area cultivated, or on a village as a whole.

Again, the agriculturists being under the Revenue officials, there are not wanting instances where, owing to the absence of a proper understanding between these officials and those of the Forest Department, friction has been caused upon the closing of the forests, or by the issue of orders to stop the lopping of trees for *rab*.

Summary of
difficulties of
Forest Department
and its
future policy

175 Thus, partly from the nature of its action, of necessity restricting one, but mainly from the obligations put upon it by the Executive Government, also from the impossibilities it has been asked to perform, and lastly, from being greatly undermanned, the Forest Department has not been as popular in the past as it might have been. But I am sure that when it is fully recognised that

there are other ends which the Forest Department should serve besides that of growing timber and making a large revenue out of the forests, the Department will readily carry these out to its best ability.

Such an end is that which I have indicated, the provision, for the agricultural community *primarily*, of facilities for obtaining what they require, viz., small timber, wood for implements, firewood, leaves, grass, or, where possible, grazing. No action would, I am sure, do more to render the Forest Department popular and its work one of wide-spreading benefit, could it be instructed to carry out such objects as the above, and to bring these facilities to the cultivators' doors. Such a policy would be one of *giving*, and not what the people have considered the past policy, one of *taking away*. The cultivators would then feel that the forests were a real benefit to them, and possibly much unculturable land would become clothed with trees and grass.

I cannot better conclude the consideration of this portion of my Report than by giving the following extract from a Resolution of the Madras Government, issued in October 1890, upon this subject:—

Paragraph 24 — "It is, however, most necessary to correct the idea, which prevails somewhat widely, that as soon as a forest is reserved, cattle and men are to be excluded, and it is to be worked for the profit of Government rather than for the benefit of the people. It cannot be too strongly affirmed that the chief object of the reserved forests throughout the greater part of the country is the provision of pasture, small timber, fuel, and leaves for manure or litter. These are to be worked in order to meet the wants of the villagers in these respects, and are not to be converted into close preserves for the growth of large timber."

Resolution of
the Madras
Government
October 1890

This important Resolution exactly expresses the opinions I had already formed and it is in the direction indicated that I think future policy should proceed.

176 I am aware that changes cannot be effected without expenditure of money, and perhaps a diminished revenue may be the result, at least for a time. But I have attempted to show that sale of timber may not country at large and attended by increased revenue to the State from cultivated land. It has also to be remembered that a very large portion of the revenue of the Forest Department is derived from rich grazing grounds which have been transferred to it from the Land Revenue Department. The Forest Department, in being a revenue earning one, starts with the following advantage in favour of its old policy as against the one I recommend, that, if timber be sold, the return is an *actual* one, whereas if the plan I advocate be followed, the increase will be a *potential* one, it cannot be directly translated into figures. Nevertheless, I trust I have said enough to show that action in the direction of providing for agricultural wants and primarily as regards the supply of fuel, is inseparably bound up

The policy of
Government

with the prosperity of the agricultural classes, and with the maintenance of the Land Revenue of the State.

Plantations
along canal
banks, rail way
lines, etc

177. Next to the forests come the plantations which have been established along canal banks, lines of railway, and other selected spots, primarily for the supply of fuel to towns and railways, and not with special agricultural intent. As mentioned in paragraph 163, plantations have been made along the banks of canals in the North-West Provinces and the Punjab, and such towns as Cawnpore, Agra, Rurki, and Delhi are thereby supplied with fuel. It was reported in 1889 that in the North West Provinces there were 36,037 acres of plantations along the banks of the Upper Ganges, Lower Ganges, Agia, and Eastern Jumna Canals. These are, however, under the control of the Irrigation Department, and not of the Forest Department, and no effort is made to create a local market for the wood, hence it all goes to the large towns, and the plantations are of little local agricultural use. In addition, the system of letting out grazing is by no means satisfactory, in many parts the cultivators arrange among themselves, so that there is no competition for the privilege of grazing, and one man will thus purchase the right of grazing over an extensive area for a merely nominal sum, putting on as many cattle (including his neighbours') as he can, and in turn receiving payment from those whose cattle he admits. In other cases grazing is not allowed, but only the cutting of grass. If the working of these plantations were put under a forest officer they would probably be better seen to. Along the Cawnpore Canal the plantations are 40 feet deep, *badul*, *neem*, *pepul*, and other varieties of *ficus*, *dhak*, *sissu*, and *jarman* are the principal trees grown. The native proprietors (*zamindars*) in the neighbourhood sometimes have plantations of their own, mostly of *dhak* and *badul* wood, every three years they cut these over and send the wood into Cawnpore.

Changa Manga

Changa Manga is a large plantation of 10,000 acres situated along the North-Western Railway, and watered by the Bari Doab Canal. It was started in 1866, and its object was to provide fuel for the railway. *Sitsham* (*Dalbergia sissoo*) is the tree grown, and it is cut on a 15 years' rotation. I found, on enquiry, that the railway company takes the whole of the wood, although only supposed to have that which is above 2 inches in diameter. The smaller wood, 1 to 2 inches in diameter, is re-sold by the railway company. A large quantity of grass, mostly of a coarse nature, grows in the plantation, and to this I shall refer in the next chapter. But I would mention that, so far as I could see, the Changa Manga plantation does not serve any agricultural end whatever, except within a very limited circle. It simply supplies wood for the railway, instead of the latter burning coal. Nearly the same remark may be applied to the Shahdara plantation, near Lahore, established in 1865, and covering 1,254 acres. The river is close at hand, and the soil is moist in consequence; *sissu*, again, is the wood grown. The original intention was to supply fuel for the railway, but now the whole of the wood goes to a contractor at Lahore, for use in the

town as fuel. Occasionally a little grazing is allowed, but the forest officers are evidently adverse to it.

None of these plantations, accordingly, whether along canal banks or elsewhere, serve agricultural ends as usefully as they might be made to do, and improvement in the system of their working is possible. These plantations have little agricultural value which, like C. benefit the even to towns, a certain amount of cow-dung is released which might otherwise be burnt as fuel.

178. More agricultural in purport than the foregoing is the system of Arboriculture, the spread of which has been pushed on with commendable energy, mainly by the Directors of Provincial Departments of Agriculture. Arboriculture Apart from a possible influence on climate, the provision of shade and shelter, and ultimately of timber and fuel, cannot but be beneficial. If trees such as the *prosopis*, the *makua*, and the *jack-fruit* tree, were grown, they would in time of famine be very useful in supplying the people as well as the cattle with food. The fruit of the *dadul*, for example, is a very good food for cattle.

It is very desirable to encourage the planting of trees by private individuals, and to hold out inducements for the doing of this. The feeling of possession, as instanced in the case of a man digging his own well, is one that acts as a strong incentive to agricultural improvement, and it should be fostered in every way. In Prince Edward's Island "arbor societies" are formed with objects similar to this above, and in several States of America special inducements are held out for the taking up of land for the purpose of growing trees.* Wood growing in America

The rule was the same as that of the "Tara" rule, which was introduced in 1888-89. It was to be allowed plantations on it. But the rule was, unfortunately, rendered inoperative, for if another man wanted to grow crops on the particular area he got the preference, and so the rule really was never made use of. I consider that the North-West In 1888-89,

on Arboriculture, and the receipts amounted to Rs. 47,084. In the Central Provinces, during the same year, 29,000 trees were planted. But in Bengal and in Bombay little has been done. In a part of the country where, as in the North-West Provinces, the forests are confined to the hills, and wood and shelter are notoriously deficient, it is of the greatest importance to show the benefit which the planting of trees along roadsides may confer. *Casuarina* is a tree well suited to sandy lands, and the growing of it in parts of Madras has

* This is done under an Act known as the Timber Culture Act. A period of eight years is given during which to raise 10 acres of trees on a 160-acre holding. It must be shown that the timber is to be used for the exclusive use and benefit of the applicant and not for the purpose of speculation or for the use and benefit of other persons. An entry fee of \$14 (21 lbs.) is paid, and a like sum at date of fuel proof. If, at the conclusion of the term, at least 65 thriving trees can be shown per acre, a title deed to the land thus planted is given.

been very successful. In the Native State of Kapurthala I noticed that plantations of ~~acacia~~ and other trees had been made on bare places around the town of Kapurthala, wherever possible. The

at the State, as an encourage-
which had been planted by
just off the roadside.

Undesirable to
plant trees close
to cultivated
fields

It is well, however, that I should here interpose a caution as to the undesirability of planting trees, more especially *babul*, close to the edges of cultivated fields, at least where cold-season (*rabi*) crops are grown. The roots of the trees run out in search of moisture and nourishment, and thus deprive the crop of each, especially the former. I have seen numerous instances of a *rabi* crop being damaged in this way; with rainy-season (*kharif*) crops and where there is abundant rainfall, it does not, however, matter.

The need of
creating more
"reserves"

179. But, after all, and even were the existing "reserved forests" to be devoted, where possible, more to agricultural ends, there would not be enough reserved areas to meet the demand. The "reserved forests" can only serve a certain circumscribed area, and there must yet remain, especially in the North West Provinces, large tracts where trees, much less forests, are almost unknown. It is in such districts, untouched by forests, that the endeavour must be made to create "reserves." It is hardly necessary to say much in proof of the above, the fact is almost universally admitted. The following instances, gathered in the course of my tour, may, however, be usefully given, as showing the scarcity of firewood, and that the price of it is more than the cultivators can afford to pay in order to replace cow-dung by wood for fuel.—

Instances of the
scarcity of fire-
wood

North West
Provinces

At Cawnpore the price of firewood is 4 annas per maund (80 lbs.) or 1 rupee for a little more than 300 lbs., whereas 100 pieces of sun dried cow-dung cakes (*bratties*) only cost 2 annas, or 1 rupee for a whole cartload, weighing some 700 lbs., about three cartloads going to the ton.

At Baki, which is supplied from the canal plantations, firewood costs Rs. 22 for 100 maunds, making the price 3½ annas a maund, or much the same as at Cawnpore.

Punjab

Ferozepore is very badly off for firewood, especially along the riverside tracts. The land here wants a lot of manure, and the people are well aware of this, but have little to spare owing to their being obliged to burn it for fuel.

In the Deccan, and in the Southern Mahratta country, wood for implements is specially scarce.

At Ahmedabad the price of firewood is Rs. 2 for 10 maunds (800 lbs.) or 1

as much
8 annas
ug cakes

Ahmedabad also is badly off in this respect, the maund here is only 40 lbs., and 1 rupee will purchase only 4 maunds of firewood, or 160 lbs.

At Mahim firewood has to be fetched from the forest; this implies a three days' journey there and back, the cost for a small cartload is 8 annas.

The cost at Belgaum is Rs. 2 to Rs. 3 a cartload, but it has to be fetched from a distance of eight miles off.

Even at Mercara, where the Coorg forests are not far off, firewood costs Rs. 3 a cartload, and at Hunsur, the depot of the Coorg forests, the charge is Rs. 3 per ton. It has however, to be carted 18 miles, at a cost of 14 annas a ton more, before it can be of any use to the cultivators.

A cartload of 1 000 lbs. of firewood costs Rs. 2½ at Shyoli, and at Madra a bulky load (three to the ton) sells for Rs. 4 to Rs. 5, but it has to be brought some 20 miles.

Mr. Benson, writing about Bellary, says—

"The supply of cattle manure is small, except in a few places, owing to the scarcity of wood for fuel. One of the greatest wants of the district agriculturally is a better fuel supply, and this is an object which is worthy of the most careful attention."

Mr. Nicholson says of Kandr—

"The want of fuel is a great hindrance to the planting of hedges and building timber is scarce. In the Bellary district firewood costs Rs. 10 and 12 per ton."

Mr. Barn writes thus of Chota Nagpur—

"The mass of the people are too poor to buy fuel. No improvement under Bengal's head of burning dung will take place until fuel is rendered cheap and accessible. There are no fuel reserves belonging either to Government or individuals. Around Ranchi firewood is scarce and jungles inaccessible."

I could multiply these by a great many other instances which I have met with myself, or which I have collected. In Chapter VII, paragraph 129, I have already shown that wherever wood is sufficiently plentiful it and not dung is the general fuel, and that manure being thus set free for the land, the cultivation has benefited immensely, such instances are Nadiad, Hospet, Avenashi (Coimbatore), Hoshiarpur, Multan, and many others.

As affording a contrast to the remark made above by Mr. Benson on the scarcity of wood in Bellary another quotation from that gentleman, when speaking of Cuddapah, will illustrate my point well:—

"The abundance of fuel in the neighbourhood prevents the use of bratties extensively for fuel, so that the soil receives a good deal of what is removed from it by the crops raised."

180. Having instanced sufficiently the need of more firewood for agricultural purposes, I must now express my concurrence with the views that have been expressed both by Governments and by individuals, that the way in which the supply of wood to agriculture can be best increased is by the creation of new enclosures of land for the purpose of growing wood, scrub, jungle, and grass. Such enclosures are now denominated "fuel and fodder reserves."

The need is best met by the creation of Fuel and Fodder Reserves.

I shall indicate briefly what has been done in this direction, and then try to point out in what way extension or modification of the system is called for.

Opinions
in favour

The establishment of "Fuel and Fodder Reserves" was advocated successively by Sir D Brandis in 1873, by the Famine Commission in 1879, and by the Government of India in 1883, acting upon the recommendations of the Famine Commission (*see* paragraph 163).

Sir Edward
Buck

Sir Edward Buck, when an officer in the North-West Provinces, warmly advocated the establishment of these "reserves," and to him is mainly due the initiation of experiments on their formation over ravine lands and salty land (*usar*) plains in the North-West Provinces (*see* paragraph 75).

Mr J B Fuller

Mr J. B. Fuller, writing on the subject in 1887, says —

"The desirability, in the interests of the people of establishing fuel and fodder reserves is admitted on all hands

The Madras
Resolution
Oct 1890

More recently (October 1890) the Madras Government issued the important Resolution on the policy of their Forest Department, to which reference was made in paragraph 175, and from which I will now further quote:—

Para 6—"The question of the provision of fuel is hardly less important than that of pasture. In many parts of the Presidency the supply of firewood is so scanty that the people suffer considerable inconvenience and discomfort. But this is not the worst, wood being dear, the dung of cattle is used in its place, and the soil is thus deprived of the manure of which it stands in such urgent need. Any measures, therefore, which tend to improve the supply and lower the price of firewood would be of immense advantage to the cause of agriculture in this country."

Para. 7.—"For the reasons set forth in the preceding paragraph, His Excellency in Council is of opinion that the establishment of fuel and fodder reserves is most desirable in the interests of the cultivating classes."

Para 24.—"Further, the Government advocates, if the area already taken up is not enough to furnish the estimated requirements in firewood, leaves and small timber, and to afford grazing for all cattle necessary for agricultural or domestic purposes, more land should, if possible be brought under management, and the natural jungle growth should be supplemented by plantations created for the purpose of fuel supply."

In the above extracts is contained the acknowledgment that the supply of firewood is still very deficient, and that existing resources are not enough, but that new reserves will have to be created.

* Fuel and
Fodder Reserves
already
created

181 We will now see what steps have been taken in this direction since Sir D Brandis and the Madras Government moved in the matter, and since the Government of India proceeded to act upon the recommendations of the Famine Commission,

Pa ri forest,
Buck!

The earliest "Fuel and Fodder Reserve," in the strict sense, that I can find mentioned is the *Pa ri forest*, near Pauri North-West Provinces

This plantation was begun in 1871, five blocks, comprising in all 80 acres, being demarcated and trees, mostly *sisna*, being planted and watered by a committee of the Government. In 1881 that committee reported that it was necessary to keep out all cattle and sheep from the blocks admitting for the protection of the forest. It was agricultural in intent.

The forests of Ajmere Merwara although of large extent and under the Forest Administration, are really "Fuel and Fodder Reserves" on a large scale. I have shown how the Government of India were able to deal with them straight away, having a direct control over them. As I have said, they more nearly approach to my idea of what "agricultural forests" should be.

control. This is quite true but when I see what has been done, as I shall tell later, in taking up land at Ftwah, Jhansi, Aligarh, and Cawnpore as well as in the plantations of Shalbara, Changa Manga, and along canal banks I cannot think the difficulties insurmountable, and if the Forest Department had been more alive to agricultural needs and less anxious to allow large financial returns more might have been done in forming other "Fuel and Fodder Reserves" like Ajmere Merwara.

Sir D Brandis started the Ajmere reserves in 1873 by taking up and protecting the then bare hills lying around one side of the valley, where the town of Ajmere is. The hills on the other side were left as they were, and were not included in the operations but were left free for whatever grazing or cutting of wood they could supply.

The villages included in the reserved part were handed over to the Forest Department, who allowed the villagers to cut and remove grass for their own use.

The villages clothed themselves with small trees and scrub, while grass sprung up in abundance.

In 1881 Sir D Brandis wrote in reference to them — "In all except the most arid tracts more protection, aided by sowing and planting in suitable places, will gradually clothe the grounds with trees and shrubs."

I visited the reserves around Ajmere and I found them to be as had been expected. The hills were now clothed with trees and shrubs, and no longer barren. The hills were enclosed by a fence, and the hills were now as helped by the Government.

The principal trees are *sisna*, *as*, *gossam*, and *babul*, and a considerable sale of dried and dead *euphorbia* bushes is also effected.

The work of protection has not been confined to the hills around Ajmere known as the 'Nagpahr forests' but another hill slope near the town and called the 'Molwa d' has been taken in likewise. Here the soil is thinner and more stony than ever, and it seems a wonder that anything whatever will grow on it. Yet, although little grazing can be afforded a good quantity of grass is cut, and *sisna* and *babul* trees grow very fairly.

From Ajmere I went to see the "Chang reserve," another one forming part of the Ajmere-Merwara forests, and about six miles from Bawar. This was begun in 1875, and comprises 3,000 acres. Here, again, the contrast between the protected hills and the unprotected ones was most marked. A great deal of firewood is cut by contract, and carted to Bawar, 2,400 camel loads (450 lbs each) and 6,572 head-loads of small fuel, coming from the "reserve" in the course of the year 1888-89. No attempt is made to grow large timber, but in the better parts *neem* seed is dibbled, and this tree does very well. Reproduction goes on very satisfactorily indeed, and protection from fire and trespass is well maintained. The grass is, as a rule, cut and removed, but the forests, in time of drought, are thrown open to grazing.

Similar "reserves," which I had no time to visit, lie nearer Merwara. The whole area comprised in the Ajmere-Merwara forests is 89,264 acres. In 1889-90 six areas of village lands, 4,395 acres in all, were voluntarily made over by the people to the Forest Department for management by them, and were constituted "village reserves." To show the value of the Ajmere-Merwara forests, it may be said that, in 1889-90, owing to failure of rain and scarcity of fodder, nearly all the reserved area was thrown open to grazing during part of the year, and no less than 14,684 head of cattle were allowed in. The fire lines (dividing the "reserves" into isolated blocks for preventing the spread of accidental fires) are burned by the people in return for the grass removed.

I have mentioned the case of the Ajmere-Merwara forests rather at length, as it is the best example of what should be tried elsewhere. The financial result at the present time shows that expenses have just been met, but, to my mind, the good that has been done, but which cannot be actually translated into figures, represents a very considerable surplus. The mere supply, to an agricultural district such as this, of wood to replace dung as fuel must be highly beneficial, and would be even more so did not Ajmere labour under the difficulty of a very uncertain and often failing rainfall.

My other instances of Government experiments must be drawn from those on ravine and *usar* land, for I have already spoken of canal plantations and others, such as Shahdara and Changi Manga, and have shown that their ends are not, in the main, agricultural ones. Even ravine and *usar* lands I have previously fully dealt with in Chapter V, paragraphs 70-76, and need say little more about them now.

Etawah, Jhansi, Cawnpore, and Awa are the chief places where tree-planting has been tried to any considerable extent, for on the *usar* land at Aligarh it has only been done on quite a small scale, and the efforts have been confined mainly to grass and crop-growing. I may here point out the financial success attending the enclosure of ravine land at Etawah.

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irrigation, a useful "fuel and fodder reserve" was formed out of what had been simply waste land. The "reserve" now brings in an annual income of Rs. 1,100, and the *remsadars*, never having parted with the land, take care to keep the proceeds too. Now, had Government done what it might have done

and bought the land outright, the continuance of the "reserve" might have been secured and the income also. As it is, the care of the "reserve" is practically in the hands of the Collector of the district for the time being, he may take an interest in it as Mr. Fidler (who originated it) and Mr. Alexander (his successor) have, but should he not happen to do so, the entire good may be destroyed.

This instance shows, however, how much may, with care, result from an expenditure of Rs. 600 only. Similar ravines to those at Etawah extend along both banks of the Ganges and Jumna, and what has been done at Etawah might be followed elsewhere, with great advantage to a Province so destitute of wood as the North-West Provinces are.

In regard to ravine and salty (*usar*) land, a careful investigation was made in 1883 in the Doab district of the North West Provinces, by Messrs W. J. Wilson and Darragh, when it was ascertained that *usar* land could be had in abundance, also that there was a certain amount of ravine land available for "fuel and fodder res-

Ravine and water
land in North
West Territories.

of purchase, which were purposely put more unfavourably to the scheme than was necessary, Messrs. Wilson and Darrach concluded their Report by saying.—

"On the whole it appears probable that plantations in the ravines will yield "a very considerable profit, and with *usar*, too both grass and trees will pay "expenses"

It was pointed out that, while doubtful whether any effect would be produced on the climate, it was certain that erosion of the soil would be prevented in ravines, and that a layer of *Humus* would be accumulated on *war* soil, whilst in times of drought the loppings of the trees would be of great value. The Report says —

"The financial loss if it occurs at all will be trifling and the advantages of protection of land from erosion and protection of cattle, in drought, would well warrant the expenditure.

That the opinion formed was a correct one is exemplified by the result of the Etawah enclosure.

Of the success which may be achieved by growing trees on salty land, the instance of the *Phagwara tahsil*, in the Kapurthala State, given in Chapter V, paragraph 75, affords proofs

were not fit for cultivation
a salt (kalar) was land
here capitally supplying

Use and at
Kapurthala

The growing of *dhal* ought certainly to be much more extensively tried on *usar* land, especially seeing what quantities of such land there are in the North West Provinces alone. The experiments made up to now on *usar* land have been directed mainly to enclosing

be formed, and if only systematic enquiry be made it will result in showing, as Messrs Wilson and Darrab's experiment in the North-West Provinces did, that there is very much more land available than has been stated.

In almost every district there are uncultivated spots among existing cultivation which would grow *babul* or similar wood perfectly well. Although it may not pay Government to take up these plots, yet, if the example of tree growing were set, encouragement would be given to native proprietors (*samsdars*) and others to adopt the plan also.

187 Having dealt with the difficulty of finding land, the second one, that of how to acquire it, must be taken

It is to acquire land

According to the ownership and the terms under which land is held, so will the procedure to be adopted vary.

Where waste land, as in Madras, is the property of Government there is no difficulty whatever, and, as we have seen, under the term "waste land" is included much land, such as the beds of tanks, etc., which is not available in other Presidencies. The matter for regret is, that, with the exception of Madras, and possibly the Central Provinces also, the amount of waste land still left is very small, but where there is any, and so placed as to be of probable benefit to the people if it were turned into a "fuel and fodder reserve," such land should be thus converted.

No difficulty with Government waste land.

There is one provision I should like to see made, viz., that when trees are grown on waste land, such as the bed of tanks and streams, etc., the wood should be devoted *primarily* to the use of the people *around* and that the trees should not, as is at present the case, be periodically cut down *en bloc* and be sold by auction to the highest bidder, often being taken far away from the district. A period then elapses until the fresh trees that spring up are ready again to be cut. These plantations (they are mostly of *babul*) should be kept for the wants of the district where they grow, becoming thus really "village plantations," and they should not be cut down in one mass. The natural reproduction should also be meantime looked after.

Reservation of trees grown on tank beds etc., for local use.

188. Next comes the vexed matter of the "village waste," and whether it should be taken up by the Forest Department and worked for the people's benefit. This could not be done without, for a time at least, keeping the cattle off and excluding the people from any use of the land, until the "reserve" was fairly established. Where the "waste" actually belongs to the people, it is, I must say, a doubtful policy to interfere with the people's time-honoured rights, and they can hardly be excluded from them without considerable friction being caused, which it is well to avoid. At the same time, as I shall show in the next chapter, the value of the "village waste" whether it is not proper for feeding areas the "out of ten, and serve little purpose beyond that of providing standing room and exercise ground for half-starved herds. Nevertheless, it would be very risky to interfere with prescriptive rights

The village waste should be acquired.

This not advisable as a general rule.

and, if it is possible, it is better to avoid dealing with the "village waste." What may, however, be hoped for is, that in the more advanced parts the people, after seeing the good which "reserves" have effected in other parts, will enclose it, or a part of it, on their own account. That there is hope of this being done is exemplified by the instances of Etawah, Ajmere, and Kapurthala, already recorded. In these cases land belonging to private individuals and villages was voluntarily handed over to be worked by Government as "fuel and fodder reserves" (see paragraphs 178 and 181).

Possible case where acquisition of village waste is desirable

The one case in which "village waste" might be directly dealt with is where the amount of waste land is manifestly in excess of the requirements of the villages. This occurs frequently in the Central Provinces, and also in parts of the Punjab. The difficulty of taking up waste belonging to a village is, that only that particular village could share in the privileges, whereas if the land be Government land, or be acquired by purchase, it would be available for as many villages as it could serve. Again, the existence of rights in an enclosed area may hamper future action, and render the dealing with these rights a matter of difficulty.

On the other hand, it may often be the case that, in order to be of any use to the villages as supplies of fuel, "these reserves" will have to be near the villages, and in many parts, therefore, the only way to establish them will be to appropriate portions of existing village wastes or commons.

"Village forests"

Failure of attempts to create them

Indian Forest Act.

189 The suggestion to form "village forests," which should include the village grazing grounds and be protected and managed by the people themselves, was made by Sir D. Brandis, but the efforts to establish them have successively failed. In the Indian Forest Act (1878), a chapter (Chapter III) was inserted to provide for the assigning of the rights of Government to or over any land constituted "a reserved forest" and for calling it a "village forest." This chapter has, however, been quite inoperative, owing, I am

adverse rights, and the private rights. Often, for instance, there may be several *zemindars*, and thus several people to settle with. Anyhow, no "village forests" have been taken up or assigned under this chapter, which is accordingly a dead letter.

Land Revenue law of Punjab

In 1886 an attempt was made to amend the Land Revenue law of the Punjab, by inserting a fresh chapter (Chapter VIII) to read as follows —

"If the majority of the landowners desire, or the Local Government considers it expedient, that part of the common waste lands of an estate be managed for the production of timber, fuel, or fodder, the Local Government may proclaim that any part not exceeding one-fifth shall be so managed."

Expressions of opinion were invited on this suggestion, and, as to the value of such a it was felt that there would be compulsion in dealing with the village waste. The introducer of the Bill, the Honourable

Colonel Davies, on bringing it before the Viceregal Council in July 1886, said.—

"There can be little doubt that a power of this kind is very much wanted in the interests of both the State and the people, and from my own experience, I think I may confidently state that in many parts of the Punjab the intervention of Government to bring about the results aimed at by this chapter will be welcomed by the people."

The Secretary of State, however, on the matter being referred to him in November 1886, considered Chapter VIII as an innovation, and that interference in the internal affairs of villages might possibly be distasteful to the communities concerned, so he expressed the hope that the reply would be very carefully considered.

The subject was thereupon dropped for the time

The Madras Government, in their Resolution of October 1890, already alluded to, discussed this matter and the various efforts which had been tried. Their opinions were expressed as follows —

Madras Resolution of Oct 1890

Para 23 — "The Madras Government now (October 1890) is of opinion that the idea of village forests must be altogether abandoned, that it is desirable to have the sources of fuel and fodder supply under Government control, and to have the reserves in fairly large blocks."

It is a mistake, I think, to assign any rights to a village community, and to have village forests managed by the community uncontrolled. The tendency of our Government and not communities must have control of all forests. To a considerable extent, been to break down now for the most part they are communities. What is wanted is, while retaining control over these forests, to work them for the people's interests.

190 Short of actually purchasing land outright, there is a provision in force in *malguzari* tracts, such as the Central Provinces, by which the proprietor (*malguzar*) may be called upon to use excess waste land for the common good.

provision is made in Central Provinces for use of land for common use

In the Settlement of the Central Provinces it was stipulated that the rights of ownership to forest land would be subject to restrictions in the interests of the village communities, and of the country as a whole. Tenants were to retain their customary rights of "user," and Government had the power of prescribing rules to prevent reckless clearing of land and sale of all the timber.

Central Provinces

In the Central Provinces Administration Report for 1887-88 it is said — "The increasing value of jungle produce leads *malguzars* to advance claims of exclusive right to the use of village wastes and forests, and they sometimes cut down and sell all the timber of their village. This is opposed to the principles of *malguzari*."

Such a provision is, in effect, — and the extension of it to other employed for the purpose of preserving In Bengal and other *zamindari* —

Extension of such provision desirable

be passed to lay the obligation on the proprietor to grow firewood, and to preserve these supplies for the common good

The shortest and probably the best way, however, in *semindari* tracts is for Government to step in and buy the land outright

Land Acquisition Act.

191 It is a question, I believe, whether a simple ruling of section 8 of the Land Acquisition Act could be taken to include the formation of areas for "fuel and fodder reserves" or whether the Act would have to be amended so as to include the formation of these. This is a point I can express no opinion upon, except that it is very desirable that Government should be able to purchase land with this object in view. The amount of Government waste land, though sufficient perhaps in Madras, is, for the most part, manifestly deficient elsewhere, and the acquisition of fresh land is undoubtedly called for in order to supply the proper amount of fuel required.

The work of afforestation must be done gradually

192. I am far from advocating the covering of the country all at once with village forests. Whatever is done must be done carefully, and at first experimentally, even where a large area of land is available, it may be better to take up only a portion at first and to extend it if successful. But the plan should be given, what it has not yet had, a fair trial.

Enquiry is needed to ascertain areas suitable

By enquiry alone can it be ascertained whether there are any purchasable areas, and whether they would be suited for the purposes contemplated. No general rule for purchase can be laid down, all depends upon where and what the land is, and what it costs

Estimate of cost of land per acre

193 Where land has to be purchased it is recognised that, as soon as this fact is known, absurdly high prices are asked, although the land may be bringing in next to nothing.

The estimate of the North West Provinces Government was, that, so long as land did not cost above Rs. 20,000 for 10 square miles or a little above Rs. 3 an acre, it would pay to buy it, and, as has been stated, when Messrs. Wilson and Darrah came to enquire, they found far more land available and purchasable within the price fixed than had been expected. Further, they found that the financial prospects were fair even after making calculations unfavourable to the scheme. The estimate of cost, it should be said, included that of fencing with stone uprights and barbed wire.

In the North-West Provinces there is almost any quantity of salty land (*usar*) available, but its frequent occurrence amidst cultivated land adds to the cost of purchasing blocks which include cultivation, and to the expense of enclosure which would then be necessary. Still, there are many tracts which are entirely *usar* land

In the Central Provinces Government is generally able to purchase unculturable land at 1 rupee per acre, and culturable though uncultivated land at Rs. 2 per acre, so that here, where cultivation has not as yet pressed on the land, the problem of obtaining land for "fuel and fodder reserves" is not a difficult one

That land could be taken up at this rate and worked profitably there can be little doubt, judging from the experiments in the North-West Provinces, where the purchase price was Rs. 3 an acre.

194 Some practical details may now be mentioned in the working of those "fuel and fodder reserves" which will have to be created, either by the taking in of waste land or by the purchase of fresh land

Practical details in working of fuel and fodder reserves.

The area to be taken up should not be too small; a minimum of 100 acres, or possibly 200 acres, should be fixed, unless there are a number of small blocks close to one another, for which one and the same supervision would suffice. There is not, I think, need of permanent enclosure or fencing, and guards (*chowkidars*) should suffice for the purpose. Even should a stray animal find its way in occasionally, the harm done will not be great, and the owner would be liable to have his privileges forfeited if the act were repeated.

Size of area

Enclosing not requisite, as a rule

Even if enclosure were found necessary it would be quite feasible to enclose a portion at a time, and by growing a live hedge behind the protection of a barbed-wire fence, the latter could be moved on as the hedge became established. In this way successive areas of 20 acres at a time might be taken up, until the whole "reserve" was formed. It is only where small blocks occur in the midst of cultivation that the necessity of fencing is likely to arise, and then a small mound and ditch will answer best, unless it be where thorn, *babul*, cactus, prickly pear, aloe, *euphorbia*, or other hedge material will grow readily.

Aloe hedges and earth walls occur near Mysore; stone walls are used in the Deccan, at Durnoon a hedge of *euphorbia* enclosing 15 acres of land took three to four years to establish itself properly, and the cost of throwing up an embankment all round the area, and planting the hedge was Rs 53 only.

Cost of enclosure when requisite.

At Gursikran, near Aligarh, 718 acres of salty land (*usar*) are enclosed merely by a small ditch and low mound, and the cattle do not get in at all. Mr. W. B. Hudson gave me particulars of some enclosing which he had done. He made a ditch with sloping sides 6 feet wide at the top and 2 feet at the bottom, the earth being thrown up to form a bank on the top face of which thorn is planted. The whole cost was Rs 5 per 100 yards, or Rs 88 per mile. In Messrs Wilson and Darrah's experiments stone uprights and barbed-wire were used and the cost was 1 rupee per 9 feet (Rs. 587 per mile), or as much as Rs. 66 per acre for enclosing a block of 200 acres extent. Major Wingate at Mian Mir, Kohat, and hedging at much lower rates than those stated in the Report of Messrs Wilson and Darrah.

In Messrs Wilson and Darrah's

it was necessary fuel and fodder to, I think, be 2½ per month

each,

Exercise of
privileges

The privileges of using the "reserves" should be exercised in the way I have indicated before—license on payment of a certain timber, firewood, grass, etc., so long as these are required only for domestic use, *but not for sale*; also to grazing (when it can be allowed) for cattle which are the *bona fide* property of cultivators.

Control of
"reserves"

In the establishing of such blocks, and in advising as to their management and working, the aid of the Forest Department must undoubtedly be sought. Where the blocks are large enough in extent, or numerous enough to warrant it, they should be put under a Forest Officer, or be included in a Forest Circle, but where they are nothing more than village blocks, and far away from "reserved forests, they would not be under the control of a Forest officer, and in this case they would be under the control of the Deputy Commissioner, or other local authority.

The person who has the actual responsibility should be the village headman, the individual known in different provinces by the various names, *patel, lambardar, monigar, mukaddam*, etc. *Chowkidars* would be employed as the guards in actual charge. As firewood is to be taken out by the people as required, and not sold by the herd-load, the need of special forest guards to check the amount would not be experienced. In many parts which I visited, the desire was expressed by the people that they should be brought, in such matters, in connection with the Collector or similar Revenue official, rather than that they should have "fresh Departments" to control them. Although I am aware how overburdened the Collectors in many cases already are, I cannot see a better way, where blocks are small or scattered, than the plan I have indicated. Above all, there must be no collision of authority. Generally speaking, the Collector is the man who knows best what is adapted to the needs of the district.

Cutting of
timber and
grass.

It would be necessary to close the blocks entirely at first for a few years, to allow of their not to grow trees of any large and valuable wood for timber.

One-fifth or one-tenth might be cut over each year. *(this),*
scrub,
time,
soon
as can be done consistently with keeping up a continuous supply.

The trees once started, grass would rapidly make its appearance too, and I am not at all sure whether the best plan would not be to only allow the grass to be cut, but not to admit grazing at all, except in case of severe drought. Goats certainly should not be admitted unless parts can be specially reserved for them. There are many other details into which I need not enter; such as, whether blocks should be reserved for grazing, whether the whole

should be cut in rotation or not, and other points. They are questions for the Forest Department to decide upon.

In some parts it will be possible as has actually been done in the Central Provinces, to have a village committee or *panchayat* to manage among themselves the internal arrangements under the control of the Revenue authority, and to this *panchayat* the village headman would be responsible. In the case, too, of villages which might in the future follow the example set and decide to turn their village waste into a "reserve," the working of it through a *panchayat* would be a good plan. In the majority of cases it will, however, be found that the "reserves" will, at first at least, have to be worked practically by Government, and in this matter, as in the kindred instances of tea and cinchona, the Government will have to initiate the work, and then they may withdraw.

Village committees

Government will have to initiate the work

195 As to the financial prospects. Taking, for example an area of 500 acres, there would be the purchase of the land, say 1 rupee per acre, the cost of planting and maintenance, and, as annual charges, the interest on Rs 500, say at even 6 per cent, * together with the wages of two guards at Rs 2½ each per month, say Rs 60 per month. This would be per householder without pressing in them very cheaply with wood, fuel, and grass.

The financial prospects.

But as I have indicated before it is not the question of actual return alone that has to be considered. It is also the well being of the people, and the maintenance of the soil's fertility. In no way can these be better secured and the Land Revenue to the State be increased to the people as fuel, and thus used on the land. It is not, the direct financial return, but is one the utility of which must be judged by wider considerations such as, that if it be neglected, it may imperil the fertility of the soil, the prosperity of the people and the wealth of the country.

The financial return not the sole consideration

A good deal of this work may be considered as "protective" in character, and may be carried out as a measure of relief in times of scarcity or famine, and be paid for out of the "famine fund."

Be let work

196 In this connection I would mention that the profits obtained by the Forest Department at present they do simply to swell a portion of them should be devoted to the supply of wood for agricultural purposes. It will be required if the scheme is to be realised, and it would be only right that a portion of the profits should be set aside for a work having such an important bearing on the welfare of the country at large.

* This is probably unnecessarily high & per cent might be sufficient.

CONCLUSIONS

197 In so far as the differences which exist between the agricultural conditions and practice of different parts arises from varying facilities for the supply of wood, an improvement in agriculture may be expected to come from a modification of these differences. Such modification can be effected by increasing the supply of wood, more especially of firewood, to those parts which are insufficiently provided with it. The task of doing this is one clearly beyond the reach of the people, and it is to Government that they must look for help. It is possible that in some cases the people will follow, in a small way, the example set them, but the duty is one which Government must take upon themselves, just as they have done that of the supply of water.

The provision of wood as fuel, to take the place of the cow-dung at present so largely burnt because wood is so scarce, is the only practical way to ensure the sufficient manuring of the land, and the keeping up of its fertility. If this be not done the State must be prepared to meet a diminution in the revenue derived from the land, and a decrease in the prosperity of the cultivating classes.

There is no doubt that forests have been destroyed, and that cultivation has been pushed on without sufficient reservation of land for the supply of fuel. The Forest Department, happily, has stepped in to prevent the further destruction which the people, if left uncontrolled, would have continued to carry on. Originally the duties of the Forest Department were non agricultural, and consisted in the preservation and development of large timber forests. The success was judged from the financial standpoint alone. In later times, however, cultivation has spread nearer to the large forests, and wooded tracts have been reserved among existing cultivation. This has called for a change in the policy of the Department, and its functions have necessarily become more agricultural. Much good work has been done by the Department, but it is still necessary to extend it in a more agricultural direction than before. The forest "reserves" in Ajmere Merwara afford a good example of what can be done, and of the policy which should be adopted on an extended scale. After reviewing the existing supplies of wood, it is evident that the requirements of agriculture are very insufficiently met, and that the creation of further supplies throughout the country is urgently called for. The establishment of "Fuel and Fodder Reserves" is the most desirable form in

which effect can be given to this recommendation. Such "reserves" should be primarily adopted to serve agricultural ends. There is a considerable amount of land which might be taken up for this purpose. In some cases Government waste land is available, in others land must be acquired by purchase. The results must not be gauged by financial considerations alone, but by the benefits conferred on the agricultural population, the keeping up of the soil's fertility, and the maintaining of the Land Revenue to the State. Enquiry is needed in order to ascertain exactly what the requirements of each district are in respect of fuel, etc., and how these may be met. Continued encouragement should be given to the spread of Arboriculture. The Forest Department is certainly undermanned, and the present financial check placed upon its further development in an agricultural direction should be removed.

RECOMMENDATIONS.

RECOMMEN-
ATIONS

198. I recommend —

The creation of fresh "Reserves" of wood, fuel, etc. ('Fuel and Fodder Reserves'), primarily for agricultural purposes

The increase of Plantations along canal banks, railway lines etc

The further encouragement of Arboriculture

The establishment of Agricultural Enquiry to ascertain the requirements of each cultivating district in the matter of wood supply

The setting aside yearly of a portion of the Forest Revenue, to be applied to the extension of "Fuel and Fodder Reserves" to meet agricultural needs.

CHAPTER IX.

CHAPTER IX.

GRASS

GRASS

Grazing.

Grazing areas in
distant forests

199. The subject of *graze* --- with that of the foregoing chapter, the principal grazing areas, and the certain amount of grass included among the more distant forests are large pasturage areas, the value of which for this purpose has always been recognised, and which, on this account, have never been broken up. To these tracts professional graziers and hereditary castes of cattle breeders resort, taking with them from the plains the most valuable of the *varyats'* cattle, for the purpose of seeking shelter and pasture for them during the hot season. The retaining of these areas for the purposes of cattle breeding is very desirable, it is, however, not the actual cultivators who directly make use of them, but particular castes who make this their special business, and who often bring cattle from a long distance. It is in these grazing areas that the bulk of the native butter called *gha* is produced.

Grazing in
reserved
forests

200. In addition to the pasturage provided in the open and more distant forests, there is another class, but still distinct from the village "waste" or common land to which I shall refer later. This class comprises the grazing areas belonging, or which till recently did belong, to villages or individuals, but which are now included in the "reserved forests." In the Bombay Presidency (where these areas for the most part occurred) the land was known as *gairán* or "grazing," *i.e.*, land set apart for grazing cattle. It differs from the "waste" immediately around the villages in being really useful for the purpose, whereas the latter, as a rule, is little more than bare ground. The Forest Department frequently found it necessary to take in these lands when forming their "reserved forests," and in Bombay, according to the new grazing rules of 1890, the term *gairán* is to cease, and free grazing is to be provided in the open part of the forest for the "agricultural cattle" of villages which have contributed *gairán* to the formation of a forest block. These areas are let out, and communities often combine for the right of cutting grass in them.

Forest Revenue
from grazing
land

The Forest Department derives a considerable income from the foregoing grazing lands, and in looking at the Forest Revenue it is well to bear this in mind, and to remember that, whereas formerly the returns derived from forest pasture land were included in the general Land Revenue, they now go to swell the Forest receipts.

201. The provision of grazing in "reserved forests" is at once a desirable and legitimate object by which the interests of cultivators may be served. I would repeat Sir D Brandis' note, quoted in the last chapter:—

Provision of grazing in reserved forests desirable

Sir D Brandis' opinion, 1883

The Madras Resolution of October 1890 concurs in this expression, and affirms that the provision of pasture, small timber, fuel and leaves, is the chief object of the "reserved forests" throughout the greater part of the Madras Presidency (*see* paragraph 175). The importance of the forests in time of drought is very great. The Government of India's Resolution of March 1883 pointed out that even the growing of fodder-crops would not replace grazing land, because, in time of drought (except in the few secured tracts that are thoroughly irrigated), the fodder crops would fail too. The service done by grazing areas in the famine of 1878-79 has been referred to in paragraph 163. During the last Mysore famine many cattle were lost through the owners having no place where they could feed them. This perishing of the cattle involved not only a direct loss to the cultivators, but also a loss of manure to feed the subsequent crops. Had there been throughout the country such "fuel and fodder reserves" as I have been suggested in the last chapter, many valuable cattle would, undoubtedly, have been saved.

Madras Resolution, 1890

Importance of forest grazing in time of drought

202. But, notwithstanding the benefits which "reserved forests" and "fuel and fodder reserves" may afford in such times, I cannot regard the provision of grazing as an absolute necessity in ordinary times. It is for the "reserved forests" to serve if it can be given consistently with other considerations, and in times of drought it may prove invaluable, but I could not assert more than this. In brief, I would say that I consider the provision of fuel to be of the greater importance, and that it would, as a rule, be better to have the grass cut than grazed by stock.

Provision of grazing not an absolute necessity

203. When, without interfering with the general purposes which a "reserve" is to fulfil, grazing can also be permitted, well and good, but it must only be carried on under conditions which do not destroy the main utility of the "reserve."

Conditions under which grazing may be permitted.

Where natural reproduction of trees is going on, grazing must, for a time at least, be altogether excluded. If land is heavily grazed the soil gets hard, the seed that falls from the trees is eaten or broken, or, if it comes up, the shoots are trampled down. The surface soil is rendered impenetrable to forest seeds, and trees can only be got to grow by means of planting. In a forest where clearing is done by "selection"

Exclusion where natural reproduction is going on

CHAPTER IX.

GRASS.

CHAPTER IX.

GRASS.

Grazing.

Grazing areas in
distant forests

199. The subject of grass supply is closely connected with that of the foregoing chapter, inasmuch as the forests provide the principal grazing areas, and the "fuel and fodder reserves" afford a certain amount of grass for cutting. Included among the more distant forests are large pasturage areas, the value of which for this purpose has always been recognised, and which, on this account, have never been broken up. To these tracts professional graziers and hereditary castes of cattle-breeders resort, taking with them from the plains the most valuable of the *ratgats'* cattle, for the purpose of seeking shelter and pasture for them during the hot season. The retaining of these areas for the purposes of cattle breeding is very desirable, it is, however, not the actual cultivators who directly make use of them, but particular castes who make this their special business, and who often bring cattle from a long distance. It is in these grazing areas that the bulk of the native butter called *ghî* is produced.

Grazing in
reserved
forests

200. In addition to the pasturage provided in the open and more distant forests, there is another class, but still distinct from the village "waste" or common land to which I shall refer later. This class comprises the grazing areas belonging, or which till recently did belong, to villages or individuals, but which are now included in the "reserved forests." In the Bombay Presidency (where these areas for the most part occurred) the land was known as *gâirdân* or "grazing," i. e., land set apart for grazing cattle. It differs from the "waste" immediately around the villages in being really useful for the purpose, whereas the latter, as a rule, is little more than bare ground. The Forest Department frequently found it necessary to take in these lands when forming their "reserved forests," and in Bombay, according to the new grazing rules of 1890, the term *gâirdân* is to cease, and free grazing is to be provided in the open part of the forest for the "agricultural cattle" of villages which have contributed *gâirdân* to the formation of a forest block. These areas are let out, and communities often combine for the right of cutting grass in them.

Grass in
Bombay

Forest reserves
from grazing
land.

The Forest Department derives a considerable income from the foregoing grazing lands, and in looking at the Forest Revenue it is well to bear this in mind, and to remember that, whereas formerly the returns derived from forest pasture land were included in the general Land Revenue, they now go to swell the Forest receipts.

them. Camels may be classed with goats as being equally destructive, but sheep graze more than they browse, and are not nearly so bad as goats, for they do not climb up nor tear down the branches of trees.

207. Free grazing by cattle should never be permitted if it can be avoided, and the system of payment per head of cattle admitted is very preferable to that by area grazed.

Other restrictions

"Close" season

I can quite understand the necessity of having a "close" season, when grazing is not permitted, though this, unfortunately, may come at the very time that the cattle would find the forests most useful. Thus, in April and May there is great danger of fire, owing to the dry nature of the grass, and people coming in with cattle and kindling a light may easily start a fire in the forest. In June and July, again, it is dangerous to admit stock to the forest together for the future. Of forest fires I have spoken, and the damage they cause to the future growth, so that, although a temporary growth of grass may come as the result of setting the dry coarse grass on fire, this is obtained only at great loss to the forest (see paragraph 164).

Cutting of grass in reserves is preferable to grazing

208. Unless where distant forests are concerned, or where "reserves" are concerned, it is preferable to cut the grass and stack it at *ruck* for the privilege of cutting and removing one head-load of grass each day during one month. At the Etawah "reserve" the grass is cut by a contractor, and is sold on the spot for $\frac{1}{2}$ anna per head-load of about 100 lbs; this is sold at 2 annas in the village, and the price in Cawnpore is 6 annas. The grass is principally *palwa* (*Andropogon*), and *grass* (*Eragrostis cynosuroides*), also *Pollinia eriopoda*, used for the privilege of cutting and removing one head-load of grass each day during one month. The quantity of grass being beyond the requirements of the village, a scheme was set on foot to get hay presses, and to send the pressed hay to Cawnpore. A great deal of the grass is, indeed, wasted. This leads me to remark that in the case of an over-abundance of grass there is no reason why it should not be made into hay and stacked, or, if the weather be wet, the grass may be put green into pits simply dug in the ground, and so be available as silage. Either of these plans would form reserves of fodder which in times of scarcity would be invaluable.

Surplus of grass should be made into hay or else into silage

The "village waste"

209. Passing now from forests to the common grazing grounds of villages, the village commons, or, more properly, the village "wastes," I may say at once that I regard these simply as so much standing room and "as exercise grounds." As for providing any herbage, they are, except perhaps just when the rains come, absolutely useless and the existence of them is only an invitation to keep so many more half-starved cattle than the land can carry. They are instances of the destruction done by over-grazing, for, no sooner does a bit of grass show itself than it is nibbled off, and the place is soon left bare.

Mr. Sen, writing of Burdwan (Bengal), says—

"The system of cattle-grazing—and it is the same all over Bengal—is most wasteful, cattle roam without restriction, the grasses have no opportunity to grow, and it is a struggle for existence between them and the cattle."

Throughout the Deccan the village grazing ground is nothing more than "cattle standing-room." I have frequently examined these "village wastes," and have generally found them to be bare during the cold and the hot seasons, and during the rains to have little more than a covering of annual weeds. Such was the case, for example, at Baroda. At Nadiad, where the cattle were well cared for, I found that the cultivators did not use the village common at all. Their cattle were fed with the grass grown as a border round their fields, and on the village common were only the cattle belonging to tradesmen and others in the town, but not those of the cultivators.

But there is a more serious side to this matter of the "village waste." Were its influence merely negative, one might stop here, but there is no doubt that these bare open spaces are often productive of positive harm. Not only do they permit of hordes of

Frequently a source of harm.

the latter appears, it makes short work among animals so little prepared to resist it, and the "village waste" becomes a hothead of disease, and a nidus for spreading it over the country around. The impossibility of segregating affected cattle while these "village wastes" are open is one reason for the enormous loss of cattle by disease which takes place in India.

The only way to render these "wastes" useful would be to enclose them and then let only a limited number of cattle in. It would be possible to show the people what effect enclosure, even of a strip, would have, but the village common, as shown in the last chapter, is a difficult matter to interfere with, and, except where the area is more than the village requires Government could not well step in and take up the land. In some parts, as in Kapurthala (see paragraph 178), the people may spontaneously follow the example set them of planting trees but this must be left to them, although much may be done in giving them encouragement to do so.

How to make the village waste useful

210. Canal banks and plantations afford, in some cases, grazing or a supply of grass for cutting. Along the canal banks near

Grazing along canal banks and in plantations

Cawnpore
between
banks, a
binder,
along the

happens to be in the immediate vicinity, as a consequence there is no competition for it, and the whole grazing along such a strip may be let for as little as 5 annas. The canal banks outside the Changa

If this system were revived, the cultivators would again grow pasture. In this district, where the sale of cattle is an important one, it might possibly pay, even now, to keep some land down to grass. But the idea of making one part of the land feed the other is foreign to custom. A large proprietor can set land apart for this purpose, but not a *raiyat* with an average holding of $2\frac{1}{2}$ acres or so.

Mr Nicholson says of Coimbatore —

"Occasionally grass is sown for pasture (*Marial* and *Kolei Kattai*), it is kept down some years and then ploughed up and re-sown or other crops sown."

"Early in the century all the best lands were under cultivation, and only inferior ones in grass. Up to the time of the new Settlement (1850) the tenant used to hold one-fifth of his farm as pasture at one-quarter its assessment and only changed to full rates when he turned it into arable land. This was abolished at the new Settlement."

Where pasture is urgently required, encouragement may be given to its formation by giving remission of assessment, but it is only exceptionally that the cultivator will put land in grass if he can grow another crop on it.

Grass Farms, Haymaking, Silage

Cantonment
Grass Farms and
military *rakhs*

214 I have visited several of the Grass Farms which are under the Military Department, and which are intended to supply grass, hay etc., for the requirements of the mounted service. My particular object was, to form an opinion as to whether grass could be grown, and either be cut and given green, or be made into hay or silage, so as to render it profitable to the *raiyat* to keep some of his land under grass. The Grass Farms were the only ones from which I could obtain any definite particulars as to what had been done, and I have pleasure in acknowledging the readiness with which full information was given to me by the authorities. In addition to the Cantonment Grass Farms, such as those at Allahabad, Cawnpore, and elsewhere, there are the *rakhs* or uncultivated grass lands devoted to military purposes, these occur largely in the Punjab. The word *rakh* originally meant a *tree*, this shows that these areas originally were wooded ones. Now the word is equivalent in meaning to "grass-land."

System started
in 1852—

215 Without going into descriptions of any of these Farms, I may briefly say that the system of enclosing grass lands for the purpose of supplying fodder to mounted troops was started in 1852 by Sir Herbert Macpherson at Allahabad, and since then has been extended largely, so that now there are two Circles, the Eastern and the Western, under which the different Farms and *rakhs* are included. In the Western Circle, which comprises the greater number of *rakhs*, Major Wingate has been appointed Special Forage Officer. Previous to the introduction of the Grass Farm system, the practice had been to send out "grass cutters," whose duty it was to cut and collect grass for the troops from wherever

they could. As the grass chiefly came off the cultivators' fields, great friction was caused between the *rayats* and the ^{The former} "grass-cutters," and serious fights often occurred. ^{grass-cutter system}

In addition to the "grass-cutters" for British mounted corps, one "grass-cutter" was maintained between every two *sowars* or Native Cavalry soldiers, and a pony was kept for him. Pensions had to be provided for the "grass-cutters," and, altogether, their cost might be fairly put at Rs 5½ a month for each horse kept. In addition, very considerable sums had to be paid to the Native Cavalry as compensation for fodder purchased in order to make up the short supply of grass obtainable by the "grass cutters."

The cost of hay is reckoned at 8 annas a maund (80 lbs), and that of feeding a horse, at 2 annas a day, or Rs 4 a month, besides this, the *sowar* had to feed himself, and along with another *sowar* maintain one "grass cutter" and a pony between the two of them. If the "grass cutter" could not get sufficient grass, then fodder had to be purchased. The Government scale of reckoning at Allahabad was that 35 maunds of green grass, or 40 lbs of silage, were equal to 25 lbs of hay or 20 lbs of straw-chaff (*dhusa*). If the monthly cost of the rations exceeded Rs 13½, then compensation was paid to the Native Cavalry at the Government rate.

216 Owing to a full supply of grass being now obtainable by the "grass cutters" from Government grass lands, not only have a large number of the "grass cutters" of British mounted corps been dispensed with, but the claims for compensation for dearth of forage which used to be paid to the Native Cavalry have lessened very considerably at nearly all the Stations, and have ceased altogether at several of them. In 1889-90, payment of compensation had entirely ceased at six Stations in the Western Circle. Great saving has further been experienced by the reduction in the number of pensions to be paid to "grass-cutters." Thus not only is there an actual money saving, but troubles with cultivators have been stopped, the horses are believed to be less subject to anthrax (the grass no longer coming from unprotected and suspicious sources), and the Stations have been much improved, the covering of grass having prevented the blowing about of dust. A more healthy state of surroundings is also produced by the growing of grass instead of that of ordinary crops, which latter would in almost all cases have to be irrigated.

Changes effected
by the Grass
Farm system

217. The result of the operations shows that a very large saving to Government has resulted from conserving the grass lands of Cantonment and military *rakkis*, and the system is one that ought to be extended wherever practicable. Allahabad has, perhaps, been the most conspicuous success, and besides the great credit due to Sir Herbert Macpherson, to Colonel Marriott and other officers who have been successively in charge, special mention should be made of Sergeant Mcagher, who has shown much energy and ability in carrying

The financial
result

out the practical part of the work. The saving to Government at Allahabad in 1889-90 was estimated at Rs. 25,000, and for the seven years, 1882-89, at Rs 91,158; in other words, these are the sums which Government would have had to pay had the usual rations of straw-chaff (*dhusa*) been issued to transport and other animals, had full complements of "grass-cutters" been maintained for British mounted corps, and had compensation been paid to the Native Cavalry for fodder purchased to make up the "grass-cutters'" short supply of grass.

The amount of grass grown at several of the Stations, including Allahabad, has been so increased that it is now possible to supply not only the British troops, but also the Native Cavalry with it.

It is, however, with the *actual cost* of the operations of cutting, haymaking, and ensiling that I have mainly to do; though, I should add that, in making any critical remarks, it must be remembered that in most of the Stations the operations are still in their infancy.

218. The great difficulty on the Grass Farms is the employment of sufficient labour, and hence, to anyone with ideas of cheap labour in India, the cost of haymaking, etc., will appear very high for that country. I am also prevented from instituting the full comparison I wished to make, because the profits stated are not the *actual profits* of the Farms by sale of produce in the open market in competition with private enterprise (representing what is actually over and above rent, cultivation, etc.), but the returns are merely comparative, viz. as to what Government *would have had to pay* if the Farms had not existed. So I must content myself with giving a few items and making a few suggestions.

It is generally reckoned in India that from 2½ to 2¾ tons of green grass will yield 1 ton of hay. At Allahabad the amount is 67 maunds (of 82 lbs) of grass to 1 ton of hay.

The following table gives the cost of cutting and haymaking, etc., at Allahabad and other Stations —

TABLE XII. Cost of Cutting Grass and Making Hay at Grass Farms

	Per Maund (80 lbs) of Hay made	Per Ton of Hay made	English equivalent taking the Rupee at 1s 6d
Allahabad, 1889-90 —	Annas	Rs	£ s d
Cut of grass, 1 anna per maund	2½	4 2	0 6 2
Making stacking and thatching hay	1	1 2	0 1 8
Total Cost of Haymaking	3	5 4	0 7 10
Cawnpore, 1890	4	7 0	0 10 6
Lahore, 1890	5	9 0	0 13 6
The Punjab generally (accord- ing to Major Wingate)	4	7 0	0 10 6

From 1 anna to 1½ annas per maund (80 lbs) of green grass may be taken as the general rate for cutting

The cost of
haymaking is
led a.

Note for cut long
grass

219. In the comparison which I shall make I purposely take the Farm where the operations have been longest practised, *viz.*, Allahabad, at the same time, the cost here is the lowest. Comparison with cost of haymaking in England

Unmanured land at Allahabad is reckoned to yield about 48 maunds, or somewhat less than 2 tons, of green grass to the acre, but by using manure (night-soil and town-sweepings, *see* paragraph 143) the yield has been increased from an average of 2 tons of green grass per acre in 1883-84 to one of 5½ tons, or about 2 tons of hay to the acre over the whole Farm. The extent of the Farm is 3,558 acres in all.

The yield of grass per acre (5½ tons) is not unlike what ordinary good land would give in England, but this is the average over the whole of the Allahabad Farm, there being only sufficient manure to supply it to portions in turn. Where a heavy dressing of manure is newly put on, as much as six crops of grass can be got in a year, five being cut for feeding green and for silage, and the sixth for hay, while for five years the manured land will keep on producing an average of 22½ tons of grass per acre yearly.

To compare next the relative costs of cutting grass in India and in England. In England 1s. an acre for cutting by machine, and 2s. 6d. per acre for cutting by hand, are prices frequently met with.

The yield of hay per acre in England is from 1½ to 1½ tons, as against the 2 tons per acre at Allahabad, so that the cost of cutting would at most be only 2s. a ton in England as against 6s. 2d. in India. A rate of 6s. 2d. per ton of hay, for cutting alone, must be considered enormously high in a country of cheap labour like India, where an agricultural labourer, one may say generally, can live quite happily on 2 annas (or about 2d.) a day. Cutting of grass more expensive in Ind.

The total cost of haymaking on a Farm at Allahabad is according to the following table:—
 1½ tons of grass per acre at Allahabad, cost of cutting 1s. 6d. per acre, cost of carting 1s. 6d. per ton, cost of stacking 1s. 6d. per ton, cost of drying 1s. 6d. per ton, cost of baling 1s. 6d. per ton, cost of transport 1s. 6d. per ton, cost of sale 1s. 6d. per ton, cost of loss 1s. 6d. per ton, cost of waste 1s. 6d. per ton, cost of other charges 1s. 6d. per ton, cost of total 1s. 6d. per ton at Allahabad.

We are obliged, therefore, even when taking the most favourable estimates, *viz.*, those of Allahabad, to conclude that, at present, haymaking on Grass Farms in India is a dear process, the expense of cutting being the main cause. Besides, there is not the difficulty and expense of turning the hay which is met with in England, for in India the hay practically makes itself. Hay making at Grass Farm is too expensive

220. When rent and other charges are reckoned the cost of production of grass at Allahabad is stated to be Rs 3 As 10 per ton, and of hay, Rs 10 (say 15s.) a ton. The grass is estimated to be worth Rs. 7 per ton, and the hay Rs 20½ (say 31s.). This, it is true, is merely an estimate based on the fact that, if the hay had not been there, it would have had to be replaced by straw-chaff (*dhansa*) bought The estimated value of hay.

from contractors at the current rates of grass supplied by "grass-cutters."

This value is too high.

The estimated value of hay, 31s. per ton, and for such hay, or rather dried grass, as is obtained, is much above the real value, and is very apt to lead to misapprehension, for, if the *raiya* could get anything like that sum for growing grass and for haying it, he had better lay out his land for it at once wherever sale of hay is possible. A fair value to put on hay in India is from 8 to 10 annas per maund (80 lbs.), which makes it Rs. 14 to Rs. 17 a ton (say 21s. to 26s.).

These estimates, as I have shown, do not enable one to judge whether grass-farming pays as farming independently of sale to Government at comparative rather than competitive values. However useful, therefore, Grass Farms have been in the past, and whatever large economies have been effected, there is ample room for great economy still, if the cost of cutting grass and of making hay be considerably more in a country of cheap labour than it is in one of dear labour like England.

Pressing and baling of hay for camp

221. The experiment has been tried, and at times with success, to press and bale hay for transport to camps. Thus, for the Muridki camp in 1889, grass was cut from two *rakkas* at Mian Mir, and from the forest plantation at Changa Manga. Bales of hay, weighing 60 lbs. each, were made, and altogether 18,500 maunds of hay were delivered in camp, at a cost of 9 annas a maund (80 lbs.), which included 2 annas for carriage. The then price for loose dry grass in the camp was Re. 1 As. 4 per maund, and a saving of Rs. 9,000, or over 100 per cent., was thereby effected in the expenses of the camp. Besides this, if there had been less grass, and consequently a greater demand for it, the price current would have gone up, and even a larger saving would have been shown. As regards the hay sent from Changa Manga, the experiment was carried out by the Forest Department, and 5,075 maunds of baled hay were forwarded to the Muridki camp. The grass cost 1 anna a maund to cut, and at first 2 annas, then later 3 annas, per maund to make into hay. After baling and all other expenses had been paid, the Forest Department, by receiving from the camp 7 annas a maund for the grass (exclusive of carriage), realised Rs. 2,190 by the sale, and made a profit of 1 anna 3 pies on every maund, or 33 per cent. on the outlay. Not only this, but, after arrival at Muridki, the Commissariat Department, as we have seen, made a saving of over 100 per cent. to the camp expenses under this head.

Experiment at Changa Manga.

The result of the Changa Manga experiment may be summarised thus —

Cost of 5,075 maunds baled hay, delivered at Rs. Muridki, at 10 annas 3 pies per maund . . .	3,251
Cost of dry grass at Muridki, at price current, 1 rupee 4 annas per maund . . .	0,344

Saving by the experiment . . . Rs. 3,003

When I add that, on account of the difficulty of getting labour, the Forest Department ask now to be relieved from the trouble of continuing the work, and that the Commissariat Department say that they cannot get hired labour to send to cut the grass, it must strike everyone with regret that such an undertaking, yielding 33 per cent. profit to one Department, and effecting a saving of over 100 per cent. to another, should be stopped.

In another case, hay was made on *rullis* Katlakput and Chandra, near Lahore. Altogether, 1,147 maunds of grass were cut, and the hay was sold at Katlakput without being baled. In all, 952 maunds of hay were sold at 6 annas per maund, and the account stood thus.—

	Rs.
Total cost (including carriage from Chandra to Katlakput)	235
Cash received, at 6 annas per maund	337
	—
Profit	Rs. 122
	or 51 per cent.

The requirements of camps are, of course, exceptional, and a continuous demand for grass supply may not exist; without this, it is probable that the undertaking might not be a paying one from year's end to year's end.

Nevertheless, Changa Manga might always be used for supplying hay to Quetta, to which Station 2 *lakhs* (2,00,000) of maunds of straw-chaff (*bhusa*) are annually sent from Amritsar. A great saving would be effected if hay were sent instead from Changa Manga. The Forest Department says that its establishment is for forestry and not for grass-cutting; result of the Changa Manga experiment the Department says that this was itself, and, in so doing, left a lot of its forestry work untouched. The work needed a lot of supervision, and would only tempt local labour, this being insufficient for the purpose. It is also stated by the forest officers that the greater part of the grass in the Changa Manga plantation is a coarse grass called *gharam* (*Panicum antidotale*), which the Commissariat will not use, even for litter. When, however, I went to Changa Manga I saw a large amount of *anjan* (*Pennisetum cenchroides*) and of *chhimbar* (*Eleusine flagellifera*), both of which are capital fodder grasses, and might have made good hay or silage.

222. The labour question is indeed a perplexing one; the main reason of the difficulty in procuring it is, that the people will not leave their own fields to come and cut grass, for labour is required just at the time that they want most to attend to their own crops. This is at the end of the rains, when the lands have to be ploughed. Cheap labour, too, is often very inefficient labour, and I have seen with positive annoyance, near Mian Mir, coolies leisurely cutting grass with small sickles, while squatting down on

the ground, the sickle in one hand and their pipe (*lookah*) in the other. A cooly gets 1 anna for a bundle of grass weighing not more than 100 lbs, and having cut that, he generally goes away. It is seldom that a man will stay to cut three bundles a day, and, meantime, thousands of tons of grass are going to waste. The Commissariat Department has to pay even more, *viz*, 1 anna 3 pies per bundle, the cutting being let out to a contractor. I could not help looking with regret at the great possibilities open, when such quantities of grass, and fair grass, too, were waiting to be cut, and would in the end be wasted. The saving that could be effected to the country from this source alone would surprise any one who looked into the matter. And, while I urge the extension of grass schemes for military purposes, as having proved a distinct saving already, it behoves the authorities to look much more closely into the matter of economy in the charge for labour, and to see if the difficulties cannot be met. I simply throw out a suggestion why labour is not procurable is, because the work is not continuous. Might it not pay to keep up a regular staff to do this work, instead of depending on the occasional cooly who may choose to come and cut his bundle, get his anna and then go off?

223 I would make another suggestion. I am quite certain that over large areas, such as many of the Grass Farms and *rakhs* cover, an immense saving might be made by using mowing machines in place of cutting by hand. I am not in favour of introducing improved implements except in special cases, but this is one in point. Where ground is very uneven, a machine cannot, of course, be used, but there are many places where, seeing the enormous cost of cutting by hand, and the difficulty of getting labour, a mowing machine would effect great economy.

I have heard some of the Farm Overseers object to mowing machines, and to say that the grass gets knocked down rather than cut. This, however, I believe to be merely due to prejudice. It is true that a machine does not cut so closely as the Native's sickle does, and so the yield of grass will be less. But mowing machines have been tried with success at Mhow (Central India), and an acre of grass land only costs $1\frac{1}{2}$ annas to cut with a machine. A European will cut seven acres a day, a Native from five to six acres, with the machine. To cut an acre of grass by hand costs, on an average, on unmanured land, Re 1 As 13.

I am quite certain that on large areas simple machinery for cutting, tedding, etc., will pay well. Elevators for stacking hay would often be very useful. There is no reason, either, why battery horses should not be used for drawing the mowing machines. Another want is that of a portable press for compressing fodder. Those in use at present are mostly "Boomer" cotton presses, and they are all of them too heavy. What is wanted is to bring the presses readily to where the fodder is.

Silage.

224. Ensiling, or the preserving of green fodder, has been carried out at Allahabad, Cawnpore, Hissar, Mian Mir, and, on an experimental scale, at other military Stations, also on Government Experimental Farms and elsewhere. The cost of making silage

From the statistics which I institute a comparison between the making silage, and the result is as follows. The loss of weight incurred in the process is surprisingly large, and the cost is so great that it would, in most cases, have been far more profitable to have made hay.

The following table will illustrate this —

	Grass ensiled,	Silage produced	Total Cost	Cost per Ton of Grass cut	Cost per Ton of Silage produced	Per centage of good Silage.	Loss in ensiling	
	Tons	Tons	Rs	Rs	Rs	Per cent	Per cent	
Allahabad {	1898-89	2,187	1,231	5,850	2 11	4 1*	66 28	43 72
	1888-90	2,324½	1,072		1 1			
Cawnpore {	1898-89	94	10	721	1 5	4 4	30 4*	69 58
Hissar {	1898-89	94	—	606	6 7			
	1898-90	—	—		3 2		—	—

* Estimate

Taking Allahabad in 1888-89, we have the following comparison — Comparison with haymaking

2,187 tons of grass produced 1,231 tons of silage, costing to make Rs. 5,850, or 4 rupees 12 annas per ton of silage (as above).

If made into hay (2½ tons of grass=1 ton of hay), 2,187 tons of grass would have given 795½ tons of hay, costing to make Rs. 1,175, or 5 rupees 4 annas per ton of hay (as per table XII, paragraph 218)

Or, taking the figures of 1889-90 —

2,324½ tons of grass are estimated to produce 1,072 tons of silage.

2,324½ tons of grass would have produced 940 tons of hay

The value of hay being, as we have seen before, more than twice that of grass, it is manifest that, whichever year we take, it would have been very much cheaper to have made hay.

made, and this of year at n cut for hay. pies (½ anna) a maund, but when cut for hay it will cost 9 pies a maund in September and October, 1 anna in November and early December, and 2 annas afterwards

Until silage can be made with very much less loss and at much cheaper cost than in the instances given above, it is very certain that it will not be able to compete with haymaking.

Estimated value
of silage

225 At Allahabad, silage is valued at 5 maunds (of 80 lbs) to the rupee, which makes it 5 rupees 9 annas a ton, or, in English equivalent, 8s 4d, a figure which, even in England, would be considered high

This estimate is based upon the cost of its production, but here, again, the estimate is merely a comparative one, based upon what the Farm would otherwise have had to pay for purchased fodder, so that it gives us little guidance as to whether the ordinary cultivator would be justified or not in making silage

Other instances
the making of
silage

226 The following are other instances of the making of silage —

At Hisar where grass can be irrigated, it is cut for silage, as it is found to be too coarse to make into hay

Mian Mir

At Mian Mir cutting of grass begins about the middle of August and goes on to the end of December, there are four a los on *ruck* Terah, in each of which from 800 to 900 maunds of silage are made yearly

Ootacamund

I saw very good silage indeed in a silo on the Government Cinchona plantations at Ootacamund Fifteen and a half tons had been made at a cost of 4 rupees 4 annas a ton, this it will be noticed is about the same cost as at Allahabad and Lawnpore Earth to a depth of 4 feet and giving a pressure of about 400 lbs to the square foot was used to weight the silage this being I thought, an unnecessarily large amount, 1 foot depth of earth is quite enough for all purposes

Deheea

Messrs Thomson and Mylne make silage at Deheea, putting the grass into a pit simply dug in the soil.

Belgaum.

At the farm attached to the Agricultural Class at Belgaum there is a silo dug 16 feet deep in the soil, the sides being plastered with dung and well beaten

Bhadgaon

Silage has been made for several years past at the Bhadgaon Experimental Farm The silos are circular masonry pits At my suggestion a 'silage stack' was made by simply building up green fodder, grass, roadside cuttings, etc, just as a haystack would be made, but weighting the whole with stones, or any other inexpensive material that was at hand

Poona and
Nagpur

At the Poona and Nagpur Experimental Farms silage has been made on a small scale

The quality of
Indian silage.

227. I can speak very favourably of the quality of the silage produced at the different Farms and Stations mentioned above Its chief fault is that it is unnecessarily dry Of course the value depends mainly on the nature of the material used, and rich silage can never be obtained from poor material, although the process of ensilage may render coarse food more palatable.

The advantages
of ensilage

228. One advantage of cutting an early crop of grass for silage is that there are many grasses, such as numerous species of *Panicum*, which seed in the rains these may be secured as silage if rain continues whereas the other grasses, being kept back somewhat, yield a good hay crop about October when the rains are over.

It may further be said in favour of silage that, by means of it, some grass, which would otherwise have been altogether lost owing to the heavy rain, is saved by being put into the silo

229. It is, however, when one goes into the figures of the cost of production, and examines the net loss of weight between the time of putting in the grass and of taking out the silage, that one sees great room for improvement in the methods of making silage in India. I may, therefore, make a few suggestions here

Improvement possible in methods of making silage

It is quite true that the real value of the process of ensilage consists in saving what would otherwise be lost, and hence it is not always fair to compare the cost of making silage with that of making hay. This I am ready to allow, but to a very limited extent only, for I have myself seen at Allahabad, Hissar, Mian Mir, and other places, silage being made in large quantities when the weather was, and had been, as fair as possible, and when there was not the least excuse for making silage, indeed, what was going into the pits had been lying about and was really half made hay already. I would insist strongly that this is a great mistake, and that, as I have endeavoured to show, it is false economy to try and make silage when hay can be made perfectly well

Suggestions for improvement in the practice

To allow grass intended for silage to lie about is also wrong. The essential feature of silage is that it is a wet or green food, therefore it should be packed in the silo as quickly as possible, be rammed down close, and covered over rapidly. If it is left about, it may just as well be made into hay at once.

I was reminded when speaking in India on this point, that, in order to make so called "sweet" silage, it is necessary to let the grass lie about for several days after being cut, so that it may get partly dry, but my advice to those who are going to make silage is not to trouble about whether it be "sour" or "sweet" silage but to cut the grass as soon as possible, pack it as quickly as possible, and so, and getting finally as for use when all else is dried up.

The great waste incurred in making silage is due partly to loss of moisture before the material goes into the silo, partly to imperfect pressing and the nature of the sides of the pits, and, lastly, to loss in taking out the material. Of the first I have spoken, as to the second, I am convinced that where a silo is to be a regular institution and is not merely used for an occasional crop, it will pay infinitely better to have it made in brick work or masonry (*pucca*) than to have a silo with earth sides and bottom (*kuichha*). The extra initial expense will soon be covered by the extra amount of fodder saved. As regards the third point, I have noticed that, on taking out the silage, the usual practice is to remove the whole of the covering at once, and to leave the bulk exposed. This, again, is a great mistake, for the pressure

should be continued as long as possible, and the covering over the silage should only be taken off the portion which is actually being cut into for daily use.

Disagreement with views expressed as to India being the great country for silage

230. I have gone at some length into the silage question because I differ entirely from the opinions of one of my predecessors, to the effect that India is the great field for the development of ensilage. That it is the field for haymaking I am much more ready to think. With a sun and climate such as exist over the greater part of India I cannot see how it could well be otherwise. Hay requires no making, for it makes itself. Silage, I repeat, will only be useful when by means of it can be saved what would otherwise be lost.

The untenableness of mechanical appliances for the making of silage

Still less do I think there is scope for any of the patent appliances advocated for "stack-silage" making. The *rayat* may possibly be shown how to preserve green fodder, roadside grass, etc., by building it up into a stack and weighting it with stones, timber, or other inexpensive material, but where is he to find the money to purchase such appliances as have been sometimes advocated, and which cost from 12/ to 20/, and even more? Such mechanical appliances may have a certain value upon large estates possibly, but surely none upon five-acre holdings.

Experiments at Farms should be directed to the making of silage

It becomes, however, one of the useful functions which a Government Experimental Farm can fulfil, to conduct careful trials upon different methods of making silage, and to ascertain how it can be made with the least loss, and in the most economical manner. Information may thus be gained as to the crops best adapted for ensiling, and as to the adaptability of the process to the *rayat's* circumstances.

Suggestions for improvement in the management of Grass Farms

231. There are some points in connection with the management of Grass Farms wherein improvement can be effected. The Station Farms are worked mostly by Grass Committees, of which the President and Secretary are the principal members, while a Committee is also appointed by the Commissary General of the Station. The Forage Officer, the Quartermaster, and the Veterinary Surgeon are consulted in all matters requiring the orders or approval of the Commander in Chief.

Grass Committees

I cannot commend the Grass-Committee system. With President and Secretary constantly changing, it is most discouraging for a Forage Officer to work. No sooner does a President or a Secretary get to know a little of the system at one place, than, as a rule, he is transferred to quite different work, and a totally new and inexperienced man is put in his place. At Umballa the Secretary is an
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 special F a
 be greatly lessened. old

Farm overseers

In the next place, the overseers of the Farms are non-commissioned officers, temporarily withdrawn from their corps. But they

are not properly selected, and care is not taken to choose the men who, from their previous acquaintance with the work, or from any aptitude shown for it, are the best fitted for the post of overseer.

At one *rakk* which I visited I found a farm overseer, with the very best intentions, making silage out of grass that had been lying about for several days. The sun was then, and had been, pouring down with intense heat all the time, but the order had gone forth to make so many tons of silage, and he was doing his best to comply with it. I asked him (though I felt the question was needless) whether he had ever made silage before, no, he had "never heard of the stuff before, until the order came." He was the station butcher! Such a man is to be pitied rather than blamed, but it does seem wrong that, where the field for economy is so large, it should not be better aimed at.

Another ground I have for complaint is, that when capable men have been selected or after they have acquired some experience, their services are not retained at the work in which they have shown aptitude. A farm overseer, if he keeps to his work beyond a certain period, does so at the risk of losing promotion. He should be a permanent non-commissioned officer of the Commissariat Department, "seconded" in the departmental list, so that he may not lose promotion.

The frequent
changes in
management

This is, I fear, a fault of the entire Indian system, and is, thus, one hard to alter, but, in the interests of the country, I would strongly urge the desirability of retaining the services of men for work in which they have shown special capabilities. Sergeant Meagher, of Allahabad, is such a man as this, and, knowing the energy he has displayed in the practical discharge of his duties, it would be a pity were his knowledge to be lost to this branch of the Commissariat or be himself lose promotion by remaining where he is. The saving which the Military Department might effect in matters of this kind alone would go a long way towards providing the funds required for the other "agricultural improvements" which I am recommending in this Report.

* This term means that an officer while employed on work outside his legitimate sphere would still retain his departmental position and share in any promotion resorting at the expiry of his outside duty to his position in his Department.

CONCLUSIONS.

CONCLUSIONS. 232. There are differences in agricultural conditions and practice which result from the greater facilities for grazing and grass supply provided in one part of the country than in another. Improvement may come from a modification of the differences through supplying these facilities where they are most needed.

Little is to be expected from the people, the most they are likely to do is, in a few cases, to follow an example set, and possibly to convert the "village waste," or a portion of it, into a "reserve" for the provision of grazing and supply of grass. But the work will practically fall entirely to the share of Government.

In taking up this work, Government will have to avail itself not only of a knowledge of indigenous practices, but also of Western science, as shown in economical methods of haymaking, silage-making, and the use of machinery, such as mowers, hay-tedders, presses, etc.

The provision of grazing by means of the pasturage areas in the more distant forests is very desirable, especially for the purposes of cattle breeding. Similarly, where "reserved forests" and plantations nearer cultivation can afford grazing without detriment to the other interests which they are called on to serve, the provision of grazing in them is a legitimate and very serviceable end for forest officials to keep in view. In times of drought all classes of forests and woods may prove invaluable to the saving of cattle, and they should then be thrown open.

Inasmuch, however, as in ordinary times the supply of grazing cannot be regarded as an absolute necessity, and since the existence of it is not necessarily coincident with the occurrence of the best cattle, it should be restricted by proper rules as to the area to be thrown open at a time, the time of year when allowed, the number of stock admitted, and also the kind of stock. Where natural reproduction of trees is going on, grazing must be excluded, and goats should only be allowed if separate areas can be given to them. The enforcement of rules as to forest fires is absolutely necessary. In "Fuel and Fodder Reserves" it will be generally found better to allow cutting and removal of the grass than to admit grazing.

The "village waste" is almost always useless for grazing purposes, and often tends greatly to the spread of disease.

It is only exceptionally that the *raiyat* will be induced to keep land in pasture

Grass Farms have done a great deal of good, and have effected considerable economies by reducing the number of "grass-cutters" attached to mounted troops, by preventing troubles with cultivators, and by saving large sums that used to be paid as compensation for scarcity of fodder. At the same time, it is clear that baymaking, as carried out on these Farms, is much too expensively done, and great economies are possible in the saving of labour by having a permanent staff, and by the employment of machinery. The management of Station Grass Farms by Grass Committees is not good, and the whole should be worked by a special Forage Branch of the Commissariat. The officers in charge of the Farms, as also the overseers, should be selected with more regard to their aptitude for the work, and, when they have shown themselves capable men, should be retained at it, without running any risk of losing promotion thereby.

The Forest Department should co-operate more than it has done in providing grazing and grass for agricultural purposes, and in utilising the grass from plantations, etc., by means of pressing and baling hay, for military purposes.

Ensilage is at present an expensive process in India, and great improvement in the methods employed is possible. There are certain advantages in adopting the process in particular cases, but it will not become a general one in a country like India.

RECOMMENDATIONS.

RECOMMEND-
ATIONS

233. I recommend —

The creation of more "Fuel and Fodder Reserves," in order to supply Grass for agricultural purposes, and also Grazing where it can be permitted under proper restrictions.

The extension of Grass Farms, and their management by a special Forage Branch of the Commissariat.

The carrying out of investigations at Government Experimental Farms on the best methods of making Silage.

CHAPTER X.

CHAPTER X.

FODDER CROPS
AND HEDGES

FODDER CROPS AND HEDGES

Fodder-Crops.

Fodder-crops

234. In the last chapter I came to the general conclusion that the provision of grass, and of grazing in particular, while highly desirable, could not be called absolutely essential

Fodder-crops
not essential
to existence of
cattle

Nearly the same must be said of the growing of special fodder crops. Undoubtedly, for cattle, the cultivation and care of, should be extended the system to particularly is this desirable where the provision of grazing is very limited, and possibly entirely absent. Nevertheless after enquiring into the matter with some care, I have not received more than the general reply that while cattle are undoubtedly far better for green food of some kind yet they can live quite well on dry food alone.

This coincides with my own experience in England.

Experiment at
Woburn,
England

In an experiment which I carried out at the Woburn Experimental Farm a few years back, I found that bullocks, when fed on cake, meal, and hay, along with water supplied to them separately, but receiving no succulent food whatever, such as roots or grass, thrive perfectly well, although the result of the feeding with hay did not prove to be an economical one.

Experience at
Bhadgaon
(Bombay)

At the Bhadgaon Experimental Farm (Bombay) experience has shown that cattle will do quite well on dry food during the hot weather, provided that they have a little cotton seed given to them.

Mr Sabarathi
Mudhar is a
farmer at
Bellary

Mr A. Sabarathi Mudhar, of Bellary, told me that he liked to give fodder crops to cattle if he could, but that they would do quite well on dry food. For cattle in hard work, or for transit bullocks, he did not think green food so desirable. In time of famine, however, he had found the latter invaluable.

Experience at
Grass Farms

At other places also I heard the same opinion expressed, viz., that fodder-crops were not so suited to *working* cattle. At the military Grass Farms there is a similar objection to the giving of silage to animals from which speed is required.

Fodder-crops
necessary for
improvement of
cattle

235. It is one thing, however, to speak of a food not being essential for the *existence* of cattle, but quite a different thing to speak of it being necessary for the *improvement* of cattle. This is where, I believe, the growing of fodder-crops will be required.

It is true, as pointed out in the last chapter, that the existence of pasturage is not always coincident with that of the best cattle, but yet instances were adduced where, as at Nadiad, Baroda, Hospet,

etc., the feeding of cattle with green grass from the headlands of fields, the banks of watercourses, etc., was pursued with manifest advantage.

The Punjab supplies the best instances of similar advantages derived from fodder-crops. In this Province the people depend greatly on their cattle, and they take proportionate care of them. This exemplified in the Punjab

The same is seen in Behar, when the cattle of the European planters are compared with those belonging to the native cultivators. The former are fed with sugar-cane *judr* (*Sorghum*), oats, etc., as fodder, while the latter only have what grass they can pick up, supplemented by straw-chaff (*bhussa*). In Behar

The following quotations exemplify this still further:—

Mr. Benson, in his Kurnool (Madras) Report, says:— In Kurnool

"In the Cumbhar and Markapur *taluks* where the soils are generally poor and thin Nellore cattle can rarely reach a live weight of 700 to 800 lbs. In the Nandyal valley, on rich black cotton soil, the same breed fed on the *judr* (*Sorghum*) straw develop to 1,000 to 1,200 lbs."

Mr. Nicholson, in his "Manual of Coimbatore, writes:— In Coimbatore

"Kangyam cattle are famous in Dharapuram *taluk* because of the extent and quality of the pastures. The *rayas* are dependent on pastures and fodder-crops for the food of their cattle during the hot weather, deal of good fodder, are grown for kangyam garden land in February."

236 The crops most largely used as fodder-crops are *judr* (*Sor-* Principal crops used as fodder-crops

The main differences between growing a crop for fodder and This is used as fodder crop

sometimes fed green, and sometimes stacked when dry

Over the Punjab generally fodder-crops are grown for cattle, and *judr*, or *chars*, as it is there termed, is the usual one. In Punjab

In Behar, *judr* is largely cultivated as a fodder-crop. When young it is believed to be poisonous, and is put round the borders of fields to keep the cattle from trespassing on to the crops.

This crop is also grown in Gujarât (Bombay), at Poona, and

Bajra, in many instances takes the place of *javar*, but is considered inferior to the latter as fodder.

In Madras, *ragi* mostly takes the place of *javar*, but is considered inferior to the latter as fodder. The straw of *ragi* is used both as green fodder and also in the dry state.

Sugar cane

Sugar-cane (*Saccharum officinarum*), as a fodder-crop, is used principally by the European planters in Behar. Like *chana* it is sown thickly. It is chopped up when green and is mixed with dry fodder, such as oat straw, etc. This makes a very good mixture for cattle.

Maize

Maize (*Zea Mays*), called in the Punjab *makli*, is extensively used as fodder in the Punjab and also in Behar and elsewhere.

Oats, barley
wheat.

Oats, barley, and even wheat are grown for fodder, the two former principally by European planters or on Government Stud Farms. Oats are either cut green and chopped up as fresh fodder, or are allowed to ripen and are used as straw food. Oats and barley are taken by the indigo planters as change crops for indigo.

In the Punjab wheat is by no means infrequently fed off in its early stages, this strengthens the subsequent crop and prevents it from being beaten down by wind and storms.

Gram,

Gram (*Cicer arctianum*) is grazed over in the Punjab when still young. In the Balaghat district of the Central Provinces pulses are grown along the tops of the embankments of rice fields and are used for cattle.

Turnips

Turnips are largely grown in parts of the Punjab as a fodder-crop. This is the case in the Jhang, Gujranwala, Montgomery, and Multan districts.

Rape

Rape is another crop similarly used in the Punjab.

Lucerne

Lucerne, where irrigation is available, is one of the most valuable fodder-crops, especially as green stuff for horses. Not only can several cuttings (often five or six) be taken during the year, but the plant will last three or four years before requiring to be ploughed up and re-sown.

Lucerne is always grown and extensively used at Government Stud and Cattle Farms such as Saharanpur, Hapur, and Hissar, as also at Poona and other Experimental Farms.

Guinea grass

Sorgho

Next, I would mention two crops which, though tried experimentally with considerable success have not yet come into general use. The first is "Guinea grass" (*Panicum jumentorum*), and the second the variety of *Sorghum saccharatum* known as *Sorgho*. I saw both these crops growing at several of the Experimental Farms, and at the Seepore Farm, Calcutta. There is a ready demand for *Sorgho* in Calcutta by men who keep milking cows. It can be cut three times in the year.

Prickly pear

Prickly pear (*Opuntia vulgaris*) has been successfully used as food for cattle, and as (unfortunately for agriculture) it is only

tor abundant in Southern India, the utilisation of it in time of scarcity would be most desirable. The thorns with which it is covered are an obstacle to its use, but this difficulty has been overcome by Mr. A. Sabapathi Mudliar, at Bellary. On this gentleman's Estate I saw prickly pear being largely used as green food for bullocks. Women were employed to remove the thorns from the shoots after they had been cut and brought in. This they do, holding firmly the pieces of prickly pear with one hand by means of pincers roughly made out of scrap-iron bent into the requisite shape, then, grasping with the other hand a pair of tongs, also made out of scrap-iron and with saucer-like ends, they seize the thorns with the tongs and pluck them out. The pieces are then handed to another woman who cuts them into slices on a knife fixed vertically on a board, the latter being held steady by the woman's foot. A woman, receiving 2 annas daily wage, will remove the thorns from, and cut into slices ready for feeding, as much as 120 lbs. of prickly pear in a day.

It used by
Mr. Sabapathi
Mudliar at
Bellary

Mr. Sabapathi Mudliar has had experience of the value of this fodder, for during the famine of 1877, quite 75 per cent of his cattle were kept alive by means of it, they having nothing more to eat than the prickly pear and 1 lb. a head daily of rice straw.

Its value in
time of scarcity

Eight years ago, when Mr. Sabapathi Mudliar became Chairman of the Municipality, he introduced this plan of feeding the municipal cattle, and now they are fed regularly on the prickly pear, and the cost is only Rs. 4 to Rs. 5 a month per pair of bullocks.

Mr. Sabapathi Mudliar is now trying to cultivate a thornless kind of prickly pear.

237. I now give some instances showing the necessity there is for extension of the system of growing fodder-crops.

Need for
extended use of
fodder-crop

Mr. Moens, writing of Bareilly (N.-W. P.), says, in an extract Bareilly already quoted —

"There are two points on which our agriculturists need instruction — (1) growing green-crops for cattle, (2) the proper management of their 'menure'."

In Chota Nagpur fodder-crops are insufficiently known, for of Chota Nagpur, Lohardaga Mr. Basu says —

"Cattle are small owing to insufficiency of food. . . . There is too little straw in the country, not enough to give more than 2 lbs. per head to 'working cattle daily, and this is only rice straw. . . . There are no 'fodder-crops.'"

And of Palamanu he says —

"There is an insufficiency of stored fodder, but it is relieved by grazing in 'jungle waste'. . . . A lot of cattle are bred in the south and west parts in the forests."

Mr. Nicholson says of Coimbatore.

Coimbatore

"Fodder-crops are rare. *Eleusine* or *Lemna* is sometimes grown as a fodder crop on 'garden' land, but none ever on 'dry' land. The natives prefer to grow *eleusine* to maturity, and get the grain, and so double the yield. Besides, it saves irrigation from wells."

At Avenashi (Comhatore) I found that no fodder-crops were grown specially for cattle. In the rains the "dry" land quickly gets covered with a coating of grass, and this feeds the cattle

Trees as fodder

238 Trees are frequently very valuable as supplying fodder for cattle. Among the hill tribes many trees are so used, but in the plains there are also trees that serve this purpose well. The *babul* (*Acacia arabica*) is one of these. Its pods are capital food for sheep and goats, and the shoots and leaves are also eaten by cattle. Other trees and shrubs so utilised are the *Makua* (*Bassia latifolia*), different species of *Dalbergia* and *Terminalia*, the Jack-fruit tree (*Artocarpus integrifolia*), different species of *Zizyphus*, etc

Little is known of comparative feeding values of Indian fodders. I. V. Van Geysel = analyses

239 Little is known as to the relative nutritive values of different fodders in India. Dr Van Geysel, Chemical Examiner, Madras, has made analyses of South Indian fodders with the object of seeing whether they throw any light on the general preference given to some kinds over others, notably to *cholum* and *rdgi*, as against rice straw, and also for ascertaining how Indian fodders compare with English and American fodders. The investigation is not, to my mind, at all complete or satisfactory, the variations being small and the samples collected from the same district, the real conclusion being drawn

..

e, in one case, 82 per cent of 55 per cent, while rice straw from Tanjore contained only 87 per cent of aluminoids. The amounts of woody fibre are made to vary from 20 per cent in one sample to 32½ per cent in another, the ash in samples of *rdgi* straw from Salem varies from 82 per cent to 14 per cent. Many other instances I might give, all showing how much depends on the time at which these samples are harvested, the circumstances under which they are grown, etc. The relative out-turns per acre are not given, and without this there is little to go upon, for what is really wanted is to know the total amount of constituents per acre, and which fodder supplies the most and the best of these, as well as whether one sample is individually richer than another, independently of the yield per acre. As I know from experience, analyses of isolated samples taken at random will give little real knowledge, and the whole subject of food-value of straws and grasses is a very difficult one. But this instance shows well the need that there is of investigation, not from the purely analytical side, but from that of agricultural chemistry specially.

Need of analytical chemistry

Hedges

Hedges

The use of hedges as fuel and saving manure

240 In close connection with fodder-crops comes the subject of hedging and enclosing fields. Attention has been directed to the way in which, by affording a certain amount of fuel, live hedges may help to increase the supply of manure to the land

Again, they are very useful in preventing cattle-trespass and destruction of crops. Hedges are found over the greater part of Coimbatore, and Mr. Nicholson, writing of this, says —

Use in prevent-
ing cattle-
trespass

"Cattle trespass is rare, cattle and crops are protected, boundaries respected, large quantities of fuel supplied, and protection is given to growing trees

Mr. W. R. Robertson (late of Madras) mentions, in a Report on Bellary, that hedges of thorn would do much good there by affording similar protection

In Anantapur (Madras) fencing is unknown.

It is in the Madras Presidency that hedges and enclosing of fields are mostly found. I met with them generally in the Avenashi, Erode, Madara, and Salem districts, also at Hospet. But they occur in other parts of India also, for instance, I saw them at Mahim (Thána), Nadiad (Gujarat), Baroda, Ahmedabad, Jeypore, Ulwar, and also at Hoshnarpur in the Punjab. The special way in which, at Nadiad, the hedges and grass borders to the fields are utilised has been mentioned in the last chapter (see paragraph 211)

Their occur-
rence

241. As materials for enclosing fields, mud walls are used in the Ulwar State, prickly pear at Jeypore and many parts of Madras, cactus hedges at Hoshnarpur, *euphorbia* hedges around Ahmedabad, as well as generally in Madras, and also bushes in Mysore. One of the most useful hedging materials is the *mullu-kilites* (*Balsamodendron Berrys*), a thorn which is largely used in Coimbatore and parts of Salem and Madras. It is easily propagated by cuttings

Material also used
for fencing
fields

Mr. Nicholson, speaking of the advantage of hedging fields, gives the following proverb —

"Note the field that is hedged, and the cattle that are pastured." Or, to put it in another form "Compare the cattle that are penned and the cattle that are (merely) grazed,"

meaning that the condition of the penned cattle is far superior.

Where hedges are not grown it is not infrequently the case that *chars* (Sor-the main ordering a wheat crop, hemp is poisonous, and *chars* in its young state is also injurious to cattle

chars (Sor-
the main
ordering a

242. Lastly, there is a certain amount of value to be derived from hedges as fodder.

Hedges material
as fodder.

fodder,

CONCLUSIONS

CONCLUSIONS

243 In so far as differences in agricultural practice are the outcome of attention being paid, in the better districts, to the growing of fodder crops for cattle, and of enclosing fields with hedges, while in other parts these are neglected, it will be possible to effect improvement in agriculture by modifying these differences

It may not be possible to grow hedges everywhere, but the system is one undoubtedly capable of much extension, so also is that of growing fodder-crops, both being followed with much benefit. We have here to deal with the third class of differences alluded to in Chapter II, *viz*, those arising, not from purely external sources, but directly from a want of knowledge. The remedy must be sought, not in any direct measures which Government can introduce, but in the gradual adoption of the better practice by the people. Government, however, and Agricultural Departments in particular, can aid greatly in the extension of agricultural knowledge, and in the transference of the practice of more advanced districts to those which are more backward.

Fodder-crops, we have seen in this chapter, are necessary for the improvement of cattle, and in times of scarcity such materials as hedge-clippings, prickly pear, and tree s, will be found immensely valuable.

But little is known as to the comparative values of different Indian fodders, and there is a considerable amount of work in this direction which can only be done with the aid of an Agricultural Chemist.

RECOMMENDATIONS.

RECOMMENDATIONS

244 I recommend —

The extension, wherever practicable, of the systems of growing Fodder crops, and of Hedging or otherwise enclosing fields more especially in parts where no pasturage exists, or where it is very scarce.

The employment of an Agricultural Chemist for India, to investigate, among other matters, the comparative values of different Indian Fodders.

CHAPTER VI.

LIVE STOCK AND DAIRYING

CHAPTER XI

LIVE STOCK AND
DAIRYING

245 THE subject which we now proceed to discuss is one on which there is not much to be learnt from the ordinary cultivator and his methods, and, in attempting improvement, the experience of Western practice will have to be drawn upon largely.

I have already spoken of cattle as affected by climate, by the existence of grazing, and the provision of fodder-crops. Their importance as supplying the main source of manure to the land has also been fully dealt with.

On points connected with the breeding of cattle I am not qualified to enter, and hence my remarks must be of a very general character.

246 Inasmuch as both climate and soil largely influence the breeding of cattle, more especially in respect of their size, it is clear that, while improvement of the smaller and inferior breeds is possible, it is nevertheless only so within certain limits. Improvement of cattle only possible within limits

The Bengali will maintain that his cattle, though small, are strong for their size, and that bigger ones would mean more grain for them and more cost to keep. In the Punjab, on the contrary, the bullocks are large and fine, they are well fed and carefully tended.

247. Cattle represent the *raiyat's* capital, they provide the labour in ploughing and other field operations, they are used for drawing water from wells, and they supply manure for the crops. In return The food of cattle.
can pick
left after

In other parts, as, for example, in the Panjab, they are well cared for, and are fed with special fodder-crops, with green grass, oil-cakes, etc., or else they are driven out to pasturage and shelter during the hot months.

The principal seeds fully treated of in Chapter . . . seed, safflower, cotton seed . . . gram and *dal* (*Cajanus indicus*) are often given.

248. It must be allowed that there are excellent cattle to be found in the country, for, in going through it as I did, or in visiting Agricultural Shows, one may see as good cattle as can be desired. I was greatly struck with the appearance of many of the cattle exhibited at the Saharanpur and Meerut Shows, and no one can fail to be impressed with the general excellence of Excellent cattle may be found in India.

the bullocks used for transit purposes, as also of those employed in military service

The trotting cattle and driving bullocks that one meets with in Mysore, Rájputana, and elsewhere, are singularly hardy and strong.

Put, though individuals may be able to rear fine cattle and to keep up special breeds, this is something quite apart from the improvement of the cattle of the country generally, the cattle of the *ranyat*

Breeding and
selection of
cattle

249 The reason why better agricultural cattle are not more generally found is mainly because of the inattention paid to the matter of breeding and selection. Further, the superstition that exists against the killing of had cattle militates against the herds being better than they are. Still, it is not everywhere that breeding and selection of cattle are neglected. In the Bombay Presidency the Gavlis, or milkmen, follow a system in breeding their cattle, it is mentioned in Reports of the Bombay Agricultural Department that in some villages of the Presidency the people are known to purchase stud bulls at their joint expense. In Gujrat a great deal of attention is given to cattle, judicious crossing is studied, and calves are cared for, oil-seeds as well as fodder are given to the cattle. A bullock will work here for 10 years at a well, or for 15 years if not put to well work.

In the Southern Mahratta country, cattle are, as a rule, good. Nellore cattle are famous throughout the Madras Presidency, and in certain other parts. The bulls are quite big at two years old, and cost Rs 150 to Rs 200 a pair. Nellore cows are greatly prized also. Alambadi cattle are held in high esteem in the Salem district. The bulls cost from Rs 150 to Rs 250 a pair. The Administration Report of the Central Provinces for 1887-88 says—"In most districts "the bullocks used for agricultural purposes are of very good "quality."

The Panjah owes, in large measure, the existence of its fine cattle to the bulls sent from the Hussar Cattle Farm

From Palaman (Bengal) it is reported that the cattle have been improved by half-bred Debar bulls.

Bhagalpur cows are in demand all over Bengal, the bullocks are used too, but are said to eat $2\frac{1}{2}$ times as much as indigenous cattle. The Amrit Mahal (Mysore) herd was broken up in 1886, but a certain number of breeding cattle are kept by the Mysore Government at Hosur. The Bhadgaon (Bombay) herd took its origin from this.

Though the above instances can be given, it is very generally the case that the breeding of cattle is left almost entirely to chance, and that no selection is exercised. It has been pointed out in Chapter IV, paragraph 209, how largely the blame for this attaches to the "village waste," where herds of miserable cattle mix indiscriminately together.

Generally
neglected

In many parts of India the young bulls are the only sires of the young stock. They run among the herds until they are four years old, when they are castrated and turned into bullocks for plough or draught work. In this way the young bulls often become sires before they are physically fit to get good stock. After they are turned three years old they probably make fair sires, and the strongest animals do the most duty. Still, it is not uncommon to see an old bullock driving away a young bull from a cow, with the result that the latter may lose an entire season through not being served.

250. The old Hindu system of breeding is carried on by means of the sacred bulls, or "Brahmani" bulls, as they are generally termed. These bulls, dedicated to Siva or some other deity, are let loose when still young, on the occasion of funeral ceremonies, or in fulfilment of a vow. They are picked cattle, and, being sacred, are allowed to roam wherever they please, no one being permitted to kill them. The custom is still maintained, and in some parts there are too many Brahmani bulls. Sometimes considerable dissension exists regarding the bulls, and frequent troubles between Hindus and Muhammadans arise on this account. In many parts, however, the Brahmani bull is quite extinct, this being due chiefly to the decrease in free pasturage area, and to the decline of faith in the old religious beliefs.

The Brahmani bull, where he exists, is almost always a fine creature, fed on the best of everything. All that a cultivator may do is to drive the bull off his own field, though it may be only for it to go on to his neighbour's. So well does the Brahmani bull fare that it is frequently asserted against him that he gets too fat and lazy to pursue his proper calling, and that the cows get served by the half-starved bulls of their own herds instead. Nevertheless, it is very certain that were it not for the Brahmani bull many villages would be very badly off.

In some parts, however, Behar for example, the bulls are too numerous, and cause serious damage to the crops of the indigo planters. Though they do not eat the indigo shrub itself, they tread it down while searching for the grass that grows under its shade, but nowhere else. Much expense has, accordingly, been incurred by the planters in putting ditches and hedges around their indigo fields.

When the bulls get too many in number, Municipalities often seize them, and work them in the town carts. This proceeding, so long as the bulls are not killed or sold, is quietly acquiesced in.

In the North-West Provinces considerable trouble has been caused by the depredations of cattle stealers and Muhammadan butchers. Muhammadans, being meat-eaters, have not the same sacred feeling towards the Brahmani bull as the Hindus have,

and the complaint of the latter is loud that numbers of these cattle are stolen for the purpose of being slaughtered, and that their flesh is sold.

Thus, I heard at Bhirwar that the value of a bull had risen from Rs 10 to Rs 25 in consequence of the demand for its flesh. Near Cawnpore I heard complaints that there were no Brahmani bulls left, and that the cultivators have to go to the nearest man who has a bull, of whatever kind it may happen to be. The agitation has, more recently, been increased by a decision given by Mr. Justice Straught, in which he declared the Brahmani bull to be "no one's property," inasmuch as it could not be said to belong to any particular owner. The bull is thereby deprived of the protection of ownership, and becomes more than ever the prey of the cattle-stealers and butchers, while the villagers are deprived of the means of getting their cows served. Surely, such a decision cannot be allowed to stand. That men should be allowed to steal and realise money by the sale of the flesh of stolen animals, and then escape punishment on the ground that the animals are "no one's property," seems manifestly unjust, and, in the interests of the agricultural communities, the practice should not be permitted to continue.

Legal decision
as to ownership
of Brahmani
bull

Distribution of
stud bulls to
villages by
Government.

251. It is very certain that without good bulls no improvement in the cattle of the country can take place. Where Brahmani bulls exist in sufficiency there is no need of doing more, but where they are extinct, or where good country bulls do not exist, then Government can do much good by the distribution of good stud bulls.

As I shall presently show, much benefit has been derived in the Panjab from the distribution of bulls from the Hissar Cattle Farm. The same good might be done by the Government supplying other parts of the country, just as it has done in the Panjab. The privilege, when given, does not appear to have been abused. A bull located in a village or town should be under the charge of the village headman (the *patel*, *lambardar*, or similar official), and the latter should be required to report periodically to the local authority. Further, it should be the duty of the Provincial Director of Agriculture to keep himself informed as to what is being done in each district to which bulls have been distributed. I do not think that any trouble need be taken about the food of the bulls. If
 that they are fed, and the
 will suffice. The system
 cultivators can go to the farm
 and choose exactly what suits their requirements, is decidedly the best one, and should be encouraged.

It is needless to say that the result to Government cannot be a directly paying one, but it is one which should be undertaken in the interests of the people as agricultural classes.

Selection of
native cattle
preferred is to
foreign ones

252. It is well, perhaps, that I should here interpose a remark to show that, when I speak of improving the cattle by using better sires, I am not at all in favour of trying to improve Indian cattle by crossing them with English bulls. The main

object in India is to produce cattle suited for *work*, and not, as in England, to produce either meat or milk. At the Bhadgaon Farm I saw a bullock that was a cross between a Mysore cow and a Shorthorn bull, a big, beefy animal, that ate a great deal, but was not adapted to ploughing.

Again, it is not enough, nor yet always the best way, to bring in fresh fires, attention must be paid also to the *selection*, for breeding purposes, of the best cattle of a district.

253 The distribution involves the retention of the location of bulls &c. Cattle bred on Farms necessary.

I am inclined to think that the good which has already been done by Government in this direction is not to be overlooked. I had the opportunity of inspecting both the Hissar Cattle Farm in the Punjab and the Bhadgaon herd at the Farm of the Bombay Government, and without, as I have said, presuming to speak too definitely on points outside my particular sphere, I must say that I was much struck, not only with the excellence of the cattle at these Farms, but, what is more to the point, by the impress which they had left upon the cattle of the surrounding country through which I was then touring.

254. The Hissar Cattle Farm, at the time of my visit and for some years previously, had been under the able management of Captain Marrett. It covers 07 square miles in all, and has about 7,000 head of cattle on it, these being divided into herds according to the different breeds and ages. It was started as long ago as 1818, the primary object being to supply cattle to the army for artillery purposes, a secondary one was to supply agricultural bulls for the Punjab and North-West Provinces. The artillery cattle are variously bred, according as they are required for "pole cattle" or for "leaders," or for other special purposes. The Gujarât cross and the Nagore cross are mostly used as "pole cattle," and the Mysore cross as "leaders."

About 350 head are supplied yearly to the Commissariat Department.

In addition, from 70 to 80 bulls are sold annually for agricultural purposes at the Government price of Rs. 150 each. Intending purchasers are allowed to go to the Farm and to choose the bulls for themselves.

On a farm of such extent there is almost unlimited grazing ground, but the grass is, seemingly, very poor and thin. It is only on spots where the water lodges that enough grass grows to afford a cutting. There is a further difficulty, that of procuring water, for the water-level is so low that wells, if made, would have to be over 100 feet deep. Captain Marrett's efforts to supply green fodder in the form of lucerne, *jadr* (*Sorghum*), etc., are frustrated by the irregular supply of canal water, the Farm being situated at the very termination of the canal, and what water there is to spare goes first to the native proprietors (*sewirdars*).

Notwithstanding these drawbacks, the Farm appeared to me to be capitally managed, and the stock bred on it were unquestionably fine. What struck me especially was the really splendid condition of the young stock. The calves were left alone in the yards during the day, but had their mothers with them at night, the latter were not stall-fed at all during the rains, but simply grazed throughout the day, and the fact that they were able to support themselves and their calves too, is a proof of how much the grass, unpromising as it looked, could do for them. All the cattle seemed to me excellent and in capital condition, and the spot must evidently be one well suited for breeding purposes.

Of the suitability of the Hissar cattle as transport and artillery hullocks I cannot speak, but I have no doubt of the agricultural good that is being done by the Farm.

Impress made
of cattle of
surrounding
districts

Hissar was the first stopping-place in my Punjab tour, and as I went afterwards to other districts I made a point of particularly observing the cattle. I may briefly say that almost wherever I went in the Punjab I found that the existence of good cattle could be directly traced to the presence of an Hissar bull in the neighbourhood. Thus, at Lerozepore and at Gujrat (Punjab) the ordinary cattle were excellent, and in each case I came across fine Hissar bulls, roaming over the fields, just as the Brahman bulls do. These bulls, I found on enquiry, had been given *gratis* by Government but the for they are very fond of at Ferozepore will cost from of what I noticed myself, the Punjab Administration Report for 1900-01 —

Karnal — 'There were six Hissar bulls in the district at the end of the year in 1883 89 ten more were got and ten more were applied for as the demand was keen and increasing. Practical farmers are deputed to Hissar to select for themselves.

Hoshiarpur — There are 24 Hissar bulls in the district which are effecting an improvement in the local breed. The *Amindars* highly appreciate them they are no expense, they are turned loose in the towns.

Rawal Pindi — There are 14 Hissar bulls in the district.

The following is from Major Massy's Report of the Kapurthala State for 1889-90 —

'Hissar bulls are regularly imported. Fifteen Hissar bulls were distributed among the *talukdars*, and were highly appreciated. The young stock are very promising.

Major Massy adds —

'It is noted that animals of this class were never possessed before by the Kapurthala peasantry.

I also find that in 1887 two Hissar bulls were sent as far as Arrah (Behar) for use on the Government Estates there.

Bhadgaon Farm.

255 On two different occasions I visited the Bhadgaon Farm of the Bombay Government. Cattle-breeding has been established here for about 11 years, the herd having taken its origin from

the Amrit Mahal herd of the Mysore Government since imported. The main object of this part of the Farm is to breed Mysore bulls for crossing with and improving the cattle of the country around here, as at Hesar, I saw many of the cattle which were being reared which were very good, and in the country generally, and the latter if the right steps were taken to distribute the benefit. But it was not that the stock at the Farm alone were good for, as I passed through the district, I saw evidence of the impress which the Mysore cattle reared at the Farm had made upon some of the other cattle, and how superior to the ordinary cattle were those which had the Mysore "touch" in them. The people of the district have now come to appreciate this, and there is an eager demand for any young bulls that are for sale. In 1889 nine young bulls, two to three years old, were sold at an average of Rs 58 each. The young stock I saw at the Farm were also most promising. A short time after my visit, viz., in October 1890, 27 young bulls, varying in age from six months to 18 months, were sold at an average of Rs 40 each for breeding purposes. By this sale alone, Rs 1,080 were realised, whereas in the Farm Report issued previous to the sale these same animals had been valued at Rs 650 only. I regard this as a strong proof that the people of the country will before long come to appreciate any source from which good cattle can be procured. The maintenance of the Farm as a breeding farm for cattle is very desirable, and it is to this purpose that, I think, it is admirably suited, more so, indeed, than as an Experimental Farm in the stricter sense.

256 I have said that the result of distributing stud bulls from these centres cannot be directly paying one in many cases, indeed, it may at first be necessary to provide the bulls free to villages. But the work of breeding good bulls, and of improving the cattle, must not be judged from the financial standpoint alone, but from that of the good effect produced in the country generally.

257 Where conditions are suitable, and where localities require it, I am distinctly in favour of making Government made breeding farms for the supply of purposes. Where conditions are not where good sires are wanted, stud bulls might be located at Government Farms. This is done, for instance, at the Saidapet Farm, Madras. If stud bulls were located at the Cawnpore Farm it would, to some extent, remedy the deficiency already referred to in the matter of good bulls.

Court of Wards' Estates, again, would be very suitable places at which to locate bulls. It is not, however, enough to merely place the bulls at these Farms but personal energy on the part of Directors of Agriculture will have to be shown in getting the people to avail themselves of the benefits offered. When this is once done, the people will not fail, before long, to appreciate the result, and to make use of it in the future.

them. The *Guarati* and *Nallora* cows are specially noted for which the Mysore breed, for these special breeds are, however, very different to the ordinary country cattle.

Throughout Chota Nagpur the village cows are very poor, owing to insufficiency of food and want of fodder-crops, no oilcake or other additional food is given to them. From 1 lb. to 1½ lbs. of milk a day is all that they yield, and their value is from Rs. 7 to Rs 10 each. Buffaloes, however, cost here Rs 25 each, and will yield about 5 lbs. of milk per diem. Oilcake is fed to them in the dry. 2 lbs of milk is the average yield of the cows are rather better well as to buffaloes. of milk a day.

In Gujarát (Bombay) milking-cattle are much more valued. Thus, a cow will milk for seven months, giving 5 to 10 lbs. of milk a day, and will cost from Rs 20 to Rs 50. The buffalo is still more prized, and, being fed with oilcake, cotton seed, *judr* fodder, etc, will keep in milk for eight months, giving, for the first three months 20 lbs, the next three 12 lbs, and the last two 6 lbs of milk daily. Its value is from Rs. 80 to Rs 100.

Nellore cows are good milkers. Some that I saw at the Saidapet (Madras) Farm gave about 20 lbs. of milk a day. They were being fed on 5 lbs per head daily of earth nut cake and bran, with *cholum* fodder.

Improvement of
the milking-cattle

263 When such differences exist as are instanced above, it is very clear that in many parts improvement in the milking-cattle is possible. As regards buffaloes, the people seem to appreciate their value, and there is little, I think, that need be done further. But there is a good deal that may be done towards improving cows, more particularly where the sale of milk or the manufacture of the native butter, called *ghí*, is carried on. This will be found to be chiefly the case where pasture and grazing areas abound, and where the professional graziers resort with the cattle of the villagers, generally taking payment themselves in a share of the milk. Beyond where such pasturage exists, little is done to maintain the cow specially as a milking animal, but the buffalo takes its place, and the cow is looked on rather as the breeder of future plough cattle. Thus, while the distribution of stud bulls for breeding working-cattle is capable of wide extension, it will, I think, only be in special parts, and where pasturage exists in abundance, that improvement of the milking strains of the country cattle will be effected to any great extent.

This matter has, however, not been altogether neglected at Government Farms, for, at Hissar, Mysore cattle are crossed with Sind, Gujarát, Angole, and Nigore breeds, partly with the object of improving their milking properties, the Mysore breed being specially deficient in these. At the Bhadgaon Farm, Malvi cows are kept as nurse cows for the young Mysore stock, and at Poona, investigations have for some time been carried on

as to the milk producing qualities of Gujarât and Ailen cows, and on the influence of different foods upon the yield of milk.

264. Of late, efforts have been made to extend the practice of Dairy Farming in India. Mr. Ozanne, who, at the time of my visit, was Director of the Department of Land Records and Agriculture in the Bombay Presidency, was foremost in the endeavours to foster this industry. A considerable impetus was given to the movement by the visit to India, in 1889, of Mr. H. A. Howman, a well-known dairy-farmer, from Warwickshire, England, and who came out on behalf of the Dairy Supply Company, Limited, of London, for the purpose of introducing the mechanical "Cream separators," for which that company were agents. These separators were of Swedish make, the invention of Dr. de Laval, and were of a size which could be worked by hand-power. Mr. Howman also took over with him a number of other appliances for making butter. The native way of making butter is, to boil the milk as soon as drawn from the cow, then to cool it, and, after adding a little sour milk, to let it stand from 12 to 20 hours in a brass vessel narrowed towards the top. After standing, the milk is churned by the rapid twisting round in it of a stick which is kept spinning round by the hand, first warm and then cold water being added now and again, but quite empirically. The butter "comes" in about a quarter of an hour, and is strained off on to a cloth, the sour butter milk, called *śāl* or *chās*, being much relished by the people. The butter is collected, put into another brass vessel, and melted over a fire. This operation requires careful watching, and good *gāi* makers are adepts at it. In the heating, the water is evaporated, and a portion of the mass, which is probably the enclosed curd, deposits at the bottom of the vessel, the remainder being poured into jars and stored. This is the *gāi*, or native butter, so largely used in cooking, etc., and it has the property, which ordinary butter has not, of keeping good for a long time.

Mr. Howman, when he first came to India, was met with what proved to be a difficulty,—the exceptional richness of buffalo milk. But this was soon overcome, and wherever the mechanical separators were shown at work, the opinion was universal that capital butter was produced, and that the system which Mr. Howman demonstrated, that of making butter without it being at any stage touched by the hand, was an immense improvement on, and a far more cleanly method than, the native one. The butter which Mr. Howman made would also keep quite well for a week. He further showed that he could not only make *gāi* from the butter produced, but that from the separated milk the sweetmeats and curds, in which the Native delights, could be made perfectly well. The separation also gave, in the form of freshly-separated milk, a perfectly sweet and wholesome article of drink. In England the main difficulty with the cream separator has been the utilisation of the skim-milk, and this is likely to prove the same in India. If the Natives show a readiness to take it, either for drinking or for manufacture into sweetmeats, this obstacle may be overcome.

Dairy Farming in India.

Mr H. A. Howman's visit in 1889

Native method of making *gāi*

Mr Howman's experience

but not otherwise. It was, however, when Mr Howman put himself into competition with the skilled *ghí* makers that he failed in showing that he could produce more *ghí* than the native manipulator. He could always get more butter, but in making it into *ghí* the Native excelled. I cannot, however, regard the trials as by any means satisfactory or complete. In one butter-making trial which I witnessed, the native operator showed himself very clever in making up his butter with a great deal of water, so that it might weigh heavy, whereas Mr Howman's butter contained no superfluous amount. Then, when Mr Howman's butter was made into *ghí* this was done by the *ghí* makers, and it is very certain that in some cases, at least, it was spoiled by them. But the chief consideration is the following. In the absence of any chemical investigation into the nature and composition of *ghí*, it is impossible to say what *ghí* exactly is, and whether, as made by the Native, it is purely butter-fat, or whether it does not contain some amount of curd. The latter, indeed, is probably the case. The butter, as made by Mr Howman, was merely butter fat, without curd, this may account for the fact that Mr Howman obtained more butter but less *ghí*. What is really wanted is the investigation of such points as these by an agricultural chemist resident in India itself.

Mr. Howman's visit undoubtedly showed that great improvement was possible in dairy matters in India, but whether the benefit will extend beyond the European community is questionable.

265 Mr Ozanne was not slow to follow up the stimulus given to the plans he had had for some time in contemplation.

Mr. Keverter, a Swiss, who had assisted Mr. Howman, was retained in India by the Bombay Government, and the Agricultural Department started a Working Dairy in the city of Bombay. This was fitted

and so successful
concern was taken

him. Then another capitalist started a second similar business, and, at the time I left, both were succeeding well. At Poona, also, butter is similarly made by the Agricultural Department, and is sold in the town. Mr. Keverter was lent for a time to the North-West Government, and at Cawnpore and elsewhere he showed the process of butter making. He was also engaged in demonstrating that cheese might be manufactured in India. The berries of *Puneria*, it may be mentioned, can be used in India for the purpose of curdling milk, they are obtained from Sind. At the Saidapet Farm (Madras) a cream-separator is used. There is a ready sale for cream, and more is sold as such than as made into butter. The students of the college (Natives) do not care for butter, so I was informed.

266 This leads me to the consideration whether butter-making by improved methods is likely to make much advance in India. I must say I hardly think that it will, so far as the native population is concerned. Butter will not replace *ghí*, for the reason that it will not keep anything like the time that

Need of an
agricultural
chemist

Steps taken to
follow up Mr
Howman's
suggestions

Is there likelihood
that these
improvements
will give
the natives
any real
benefit?

There are about 15 cows here, most of them good country cows, and a few Aden cattle. They are reckoned to give about 12 lbs of milk each daily, when in full milk, and are fed with earth nut cake and gingelly cake. Milk is sold to the town, but not cream, butter, or ghee. This part of the Farm pays very well, and would seem to show that a good milk supply would be appreciated in native towns as well as where Europeans are in considerable numbers. Mr Oranne has in prospect the establishment of a large Dairy Farm for supplying Poona with milk, butter, etc.

Horses

269. Horses do not in India come under the term "agricultural live stock," but, inasmuch as the Horse breeding Operations of the Government of India are included under the work of the Agricultural Department, a passing reference should be made.

Horse breeding
Operations of
Government of
India.

The object of the Horse breeding Operations is, primarily, to supply Remounts for the Cavalry. Formerly there were army studs at Hapur and elsewhere, but these are now given up, and the Cavalry have been supplied with horses imported from Australia and New Zealand. The endeavour of the Horse-breeding Department has been to improve the horses of the country by mating the country-bred mares with pure-bred sires. The selected sires are either Norfolk Trotters or thoroughbreds, imported from England, besides a few Arabs.

At the different Fairs and Shows, country mares are chosen by the officers of the Department, and are branded as being eligible to be served by a stallion belonging to the Department. Their produce are intended to supply the remounts. The stallions are quartered in different parts of the country.

I went over the Hapur Farm, near Meerut, and saw the stallions of the Horse-breeding Department, and also the breeding mares, and the young stock belonging to the Army Remount Department. It is found necessary to buy the produce of Government sires at as early an age as one year, for, if left till older, the horses are found to be mostly injured permanently. Also at Bhadgaon, Lahore, Gujrat (Panjab), Hosbiarpur, and Salem, I saw stallions of the Horse-breeding Department that were quartered there. In addition to the horses, there were, both at Hapur and at the other depôts, donkey stallions kept for mule breeding purposes. In the Panjab and North-West Provinces these were very popular, but in Bombay the idea has not taken at all.

In the Rawal Pindi district (Panjab) alone, there are 26 horse stallions, and 47 donkey stallions, belonging to Government.

In the Central Provinces, Government stallions are located, but are not much used, trotting bullocks being generally used for transit purposes.

It would be travelling beyond my sphere were I to pass any detailed criticism on the way in which the Horse-breeding Operations are conducted. I can, at most, mention my general impressions of what I saw, without wishing to attach much importance to them. But, after seeing Norfolk Trotters in England, I cannot say that I was favourably struck with the representatives of the breed that had been sent out to India, they appeared to be too heavy, too large-bodied for their legs, to have a lack of style and a coarseness of leg which did not bring back to my mind the specimens I had seen in England. It is, I believe, questionable whether the Norfolk Trotter is the right kind of horse to cross with the country mares in order to produce a *cavalry* Remount, the appearance of the young stock would indicate their suitableness for dragging guns rather than for making riding horses.

In the case of the thorough-breeds, the acquiring of a good animal seems to have been sacrificed to the obtaining of a high-sounding pedigree. Of a number of horses that I saw at Hapur, the majority were rather "weedy-looking," and several were lame. But the money difficulty comes in here, and when, as is the case, the purchase price is restricted to 250 guineas, or 300 guineas at the outside, one can hardly expect to get a really good sire.

The Arab stallions were, as a rule, very good, occasionally a little light the best I saw was one named "Ajeel," then standing at Hoshiarpur.

Some of the donkey stallions were also good. The general fault with them was, that they showed a shrinking of the hoof.

270. Of other farm live stock I need say but little.

Sheep and goats

Attempts have been made by Colonel Coussmaker and others to improve the breeds of sheep, and to obtain a better wool, but nothing of a lasting or general nature has been accomplished.

At the Saidapet Farm a fresh cross-breed, called the "Saidapet breed" has been established. At the Hissar Farm Jeypore sheep have been crossed with the progeny of Leicester tups and Bikanir ewes. It is stated that the sheep now give wool, rather than the hair which they produced before.

The country sheep (Bikanir) have also been crossed with Australian Southdowns, but the latter only lived six months. Their produce, however, seemed to show an improvement in wool, the price realised for it off the farm being Rs 25 per maund, whereas the general price for country wool is only Rs 17.

The question of improving sheep and goats is partly one of providing for them a more abundant supply of food, and not leaving them to pick up merely what they may chance to find. But it is probable, also, that much can be done by careful selection of the stock already in the country, rather than by importation of breeds from other lands.

Cattle Disease

271. Comparatively little is known in India on the subject of cattle disease, and yet it is one of great agricultural importance, for, when an epidemic breaks out, the cattle perish in thousands, and do not seem to have a power of resisting it equal to that of the English cattle. The variety of names by which diseases are known to the natives in different parts makes it hard to ascertain how far they really recognise the particular ones and the respective symptoms. To a certain extent it appears that the people are aware of the advantages of isolation, and make some use of it. The herding together of a lot of miserable half starved cattle on the "village waste" is as I have previously remarked, one of the most potent means of spreading disease.

The variety of names by which diseases are known to the natives in different parts makes it hard to ascertain how far they really recognise the particular ones and the respective symptoms. To a certain extent it appears that the people are aware of the advantages of isolation, and make some use of it. The herding together of a lot of miserable half starved cattle on the "village waste" is as I have previously remarked, one of the most potent means of spreading disease.

In the Central Provinces, enquiries were lately made as to the means of checking the spread of disease, and the replies received indicated that the people would welcome Government interference to prevent the cattle of villages where disease existed, from mixing with those of other villages. But the proposed isolation of individual cattle in a village hospital pound was not so readily approved, and it was felt that the owners would want to go and feed their cattle and thus would themselves be the means of spreading infection. Yet another difficulty is that of preventing the spread of disease through the sale of hides. When cattle die the *Chamars* or leather dressers come at once and skin the animals, taking the hide for sale. The hide is their perquisite. It would seem that the only way of remedying the evil arising from this source is to give compensation for the hides destroyed.

Mr Nicholson in describing the losses of rupees annually that fencing is not done here, much loss.

272. Within recent years efforts have been made to gain a knowledge of the diseases of cattle, and of their treatment.

At Lahore (Punjab) a Veterinary College was established in 1882, and now has 90 students. A dispensary and hospital are attached to it. At Poona (Bombay) College there is a veterinary course and men who have passed through it are qualified to take charge of the local dispensaries which have now been started at Ahmedabad, Nadiad, and other towns in the Bombay Presidency. These dispensaries are used in some extent by the different municipalities for the treatment of their working cattle, and their wider usefulness is beginning to be appreciated. In the Punjab also, there are similar dispensaries, and in the Central Provinces veterinary hospital assistants are sent out to different districts to treat the cattle in them.

The most important step which has of late been taken is the appointment of Dr. Langard, a man of established scientific reputation.

Efforts made to
cope with cattle
epidemics

Dispensaries

Bacteriological
Laboratory at
Poona.

tion, as Imperial Bacteriologist to the Government of India Dr Lingard, after considerable European experience under men of such note as Drs Koch and Klein, was brought out to India in 1890, and located at Poona, a special laboratory being established for him there by the Government of India for the express purpose of enabling him to pursue original research and investigate the causes and cure of cattle diseases in India. This appointment is one of great importance, and is almost the first in which a man trained in scientific investigation has been brought to India and enabled to follow original research. Associated with Dr Lingard is a selected veterinary surgeon, who undertakes the survey of cattle diseases in India and in this capacity brings to Dr Lingard's notice any outbreaks or new diseases which manifest themselves in the country.

There is a probability that a bacteriological laboratory will also be started at Lahore, in connection with the Veterinary College there, and be used for the investigation of equine and bovine diseases.

273 In Madras, the step taken has, on the contrary, been of a retrograde character. The cattle disease branch of the veterinary department have given up, for the time, the out-
come of a Government enquiry was to report that the veterinary staff was insufficient and inefficient, and that the cultivators offered opposition to the action of the veterinary officers.

These do not appear to me valid reasons for giving up the attempt to learn more about the epidemics which annually clear off so many of the cattle of the country. The first duty should be to provide a proper training for the men who are to go about the country, such as is, for instance, being provided at Poona and Lahore. When a class of properly trained men is obtained, and efficient supervision is provided, then it will be the duty of Government to

an Agricultural Department and not (as it has been made in Madras) that of the Education Department.

I believe that the subject of cattle diseases in India opens a great field for investigation and that wide-spreading benefits may accrue to the agricultural community thereby.

CONCLUSIONS

274 Differences in agricultural conditions and practice which result from the varying qualities of the cattle of one district as compared with another arise in part from external and physical causes, such as climate, grazing facilities, etc., and in part directly from want of knowledge in breeding and selection of cattle

The impossibility of altering physical surroundings in any material degree, prevents more than a partial modification of the agricultural differences

To some extent, however, it is possible to modify the differences and improvement in agriculture will be effected by providing for the better supply of stud bulls, and for their distribution throughout the country

The people themselves will do little in this direction, and the initial work will have to be undertaken by Government. The people, however, may, as they have done in the past in the Punjab, slowly come to appreciate the advantage of obtaining good cattle

In effecting any improvement in cattle the examples of native practice will not suffice, but the experience of Western practice must be applied also

The people, may however, be induced to follow the practices already adopted in some parts of India, and may grow hedges for penning cattle and fodder crops for feeding them

The retention of Cattle breeding Farms is very desirable, but improvements in the system by which they are managed should be made. The chief alterations desirable are, the better selection of Superintendents and the continuance, in their position, of men who have shown themselves specially qualified for the work.

Government Experimental Farms and Court of Wards' Estates should have good stud bulls standing at them, these bulls being available for the use of the neighbourhood

In Dairying there is but limited scope for improvement. Where a considerable European population exists, or where troops are quartered, the introduction of better methods of butter making is likely to succeed, and it is very desirable that it should do so. With the native population not much progress will be made. The question of milk supply to troops as well as to the European population, to jails,

and other institutions is a most important one and demands urgent attention. The establishment of Dairy Farms is the best way to provide for the want of a pure milk supply. Where dependence has to be put on native milk dealers the various establishments should be under control. Up to the present there has been no scientific study of dairying matters in India, and an Agricultural Chemist should be appointed to carry this out.

Encouragement should be given to the study of cattle disease and to the employment of methods to prevent the isolating spread of epidemics. The enforcement of regulations for affected animals will have to be firmly carried out, even if opposition be at first shown by the people.

RECOMMENDATIONS

RECOM
MENDATIONS

275 I recommend —

The continuance and extension of Cattle-breeding Farms and the distribution from them to villages, through Government agency, of stud bulls suitable for improving the agricultural cattle of the country.

The making Experimental Farms and Court of Wards' Estates centres for the location of stud bulls.

The establishment of Dairy Farms for the supply of Milk to Troops and Government Institutions.

The appointment of an Agricultural Chemist to investigate matters connected with Dairy Farming.

The prosecution of Enquiry into Cattle Diseases, and into the means of preventing cattle epidemics.

IMPLEMENTS

IMPLEMENTS.

Not much scope
for improved
implements
under existing
conditions.

276. PERHAPS in no direction have efforts at improving Indian agriculture been pushed more than in that of introducing new or so-called "improved" implements. Even at the present time it is not unusual, among people who speak of the *raiya*'s farming as being "primitive" to say, "What can you expect when he uses a plough which merely *scratches* the soil?" After seeing for myself what is used, and what have been suggested for use, I am obliged to conclude that there is not much scope for improved implements under existing conditions. Not that the ones the *raiya* uses at present are perfect, or that others have not advantages, but it is equally true that the existing implements have also advantages, and the suggested ones disadvantages, both of which have often been overlooked in the past. That there is some room for improvement is shown by the success which has attended the introduction of the Bebesa sugar-mill. Still, when this has been mentioned, I confess that one cannot go much farther, and if the history of the Bebesa mill is looked into, it will be found that it succeeded only after a close study had been made of native ways and requirements, and after the machine had been adapted to these. I have no hesitation in saying that if this method be not followed it will be quite useless to spend time and money in trying to effect improvements. Even if a thing be good in itself, patience, perseverance, and energy are required to make the Native comprehend its advantages, but when once he is thoroughly convinced of its utility he will not be slow to follow it up. It took several years of waiting before the Bebesa sugar-mill began to make its way, but when once it was introduced into a district the demand for it often exceeded the supply, this has led in the past to many imitations and new adaptations of it, some bad, some good.

That improvement
is possible
is illustrated by
Bebesa sugar-
mill.

Native require-
ments must be
studied.

Ploughs

277. Ploughs have often been made, the best of attempted

tail " (Avery's) plough
ters. A certain number
cular districts named,
the ploughs, they do n

Objections to use
of iron ploughs,
1. Their cost.

reasons are several, the first being that of cost. The *raiya*'s
practice is to buy an iron share in the bazar, for 4 annas; this he

takes, along with some *babul* wood, to the village carpenter, who then makes the plough. In Eastern Bengal a wooden plough costs 8 annas only, but Rs. 2 to Rs. 4 may be considered the general price of the improved plough.

Rs. 12, As. 8. Every attempt has been made to lessen the cost, but without avail. The standard, he will be told, is not to the advantage of which has in Gujarat (Bombay) a complete set of farming implements can be purchased for Rs. 20, and one may see, as I did, the oxen returning from the fields drawing along, in one load, some four or five implements, including plough, bullock-hoe, leveller, and seed-drill.

A second objection which the *raiya* makes is the *weight* of an iron plough; it is, he says, heavy to work; his cattle are not strong enough, and he cannot carry it himself, as he does his wooden plough, on his shoulder from field to field. These contentions are often true, but not always. The native plough, generally speaking, weighs about 25 lbs., some are even lighter; the Konkan plough, for example, weighs only 20 lbs. An "improved" plough will weigh from 30 lbs. to 80 lbs. But frequently, the native plough is considerably heavier than this. The Khândesh plough, one in common use by the *raiya* of that district, weighs no less than 150 lbs.; it costs Rs. 5, is worked by one pair of oxen, and goes down 7 inches into the black soil, turning up heavy clods, which afterwards weather down. The Nagari plough of Gujarat (Bombay), on the contrary, weighs 60 lbs. (with yoke) and is drawn by from six to eight pairs of oxen. Why there should be this difference, the smaller number of cattle being used for the heavier plough, is hard to explain, still, it is the practice, so Mr. Ozanne assures me. The heavy Deccan plough is worked with as many as 12 pairs of oxen. At Shiyali (Madras) Mr. S. Sabanayagam Mudhar uses an "improved" ^{2. Their weight.}

pair, and those of Mr. Sabanayagam Mudhar, Rs. 50 a pair. The contention as to the greater weight of "improved" ploughs is, thus, not always correct,

left out on the fields at night, for fear of their being stolen.

A third and more potent objection is the *difficulty of repair* ^{3 Difficulty of repair} of iron ploughs. When, occasionally, I have found iron ploughs used in a district, it has been where a proprietor owns a small foundry, and is able to execute the repairs there. This was the case at Bellary. Mr. A. Sahapathi Mudhar sells a number of

Swedish ploughs here. Those used on the black soil go 1 foot deep, and require six to eight pairs of oxen; they cost Rs. 50 each, but a smaller size used on red soil costs Rs. 25 only. One thousand ploughs, in all, have been sold, the repairs, however, are all done at Mr. Sabapathi's factory. Mr. Sabanayagam Mudhar, at Shiyali, also has his own workshop, where repairs can be executed. Messrs. Thomson and Mylne, who make the Beheca sugar-mill, have found this same difficulty of repair, and have met it by establishing local depôts, taking back the worn-out mills from the cultivators, and replacing them by new ones, in preference to trusting to local attempts at repair. The manufacture of wooden ploughs, again, is a regular employment of the village carpenter; . . . and does not charge for . . . expense of the villagers. . . . the grain, and, in return, repairs and makes new ploughs all the year round. His occupation would be in great measure gone were iron ploughs substituted for the wooden ones.

4. The Native will not use an iron plough in the proper way.

There is yet another objection. The *rayat*, if he be given a furrow-turning plough, will not use it as it ought to be used, *viz.*, allowing it to run flat on the sole; but he will stick the point into the ground, just as he does with the native implement, and the work will be both faulty and difficult to manage. It was at Nadiad that I saw a Native working with the "Saidapet" plough, the front wheel was quite up in the air, and never ran on the ground at all. I saw the same done at Seebpore, with a plough introduced by Mr. Sen, but, when the man was shown how to use it properly, the work was very good.

That is the foreign objection; notably the first and third (cost not think that iron ploughs

Objections to deep ploughing in India.

276 Even if properly used, a plough that goes deep may do harm where a native one would not, *viz.*, by turning up inferior soil, and by bringing lumps of limestone (*kankar*) to the surface.

Again, it is quite possible that, were deeper ploughing to be in vogue, the moisture, which, in the case of some soils, it is so . . . row . . . the . . . like . . . This . . . h is . . . und, . . . rring and loosening it. For hard and sun-baked ground, such as is often met with, no action could be better adapted, and, in a trial at Meerut, I saw an English plough completely fail on such land.

I have Mr. W. B. Hudson's (Turhoot) authority for saying that for breaking up land in wet weather the native plough is better than a furrow-turning one, for the latter throws over a slice which will not break down readily.

In black soil, too, a plough that goes deep is bad, if no rain falls after ploughing.

The fine tilth produced by the frequent ploughing with a native plough produces a surface which will absorb water better if rain follows, than would that left by a furrow-turning plough.

Against it there is so little manure lost if the soil were turned.

Even when deep ploughing is employed, as by Mr. Sabapathi Mudhar at Bellary, this is only done once in four years with the Swedish plough. The native plough is used for the rest of the time.

Further, land is frequently infested with weeds, such as *Lunda* (*Saccharum ciliare*), which, if buried, will readily spring up, and whereas the native plough, with its digging action, tears the weed out and brings it to the surface, a furrow-turning plough would cover it over, and give to it the very bed it required for propagating itself. So, too, would it be with a field covered with *dūb* grass (*Cynodon Dactylon*), every joint of which will grow again. For rice cultivation, nothing but a digging and stirring plough, like the native one, would do any good, working, as it does, among mud with several inches of water over it. For breaking up new land the native plough has also advantages, and somewhat resembles the tearing action of the 'steam-digger'.

279 At the Meerut (North-West Provinces) Agricultural Show I was a witness of work done by native ploughs brought into competition with English and "improved" ones. The field had outstubble on it, and but few weeds. The English ploughs, drawn by horses, were altogether handicapped by the smallness of the plots and by the difficulty of turning, so that they had no chance of even showing quick work. But the long slices turned over (the ground being wet below the surface) soon began to dry in one mass, and looked very like forming into a hard brick under the influence of the hot sun, whereas the native plough just scraped the soil up, leaving it very fairly pulverised, and the stubble exposed on its surface. The best work, in the judges' opinion, and in my own also, was done by a "Watts" plough, for the soil was quite inverted, and yet it crumbled as it fell, covering over the stubble completely, and leaving the appearance of the field far more even than in the case of the other ploughs. The covering in of the stubble, as I shall explain presently, may be an advantage or a disadvantage, according to the nature of the weeds and grass turned in with it. But, after all, the judging of the merits of ploughs by mere inspection of the ground ploughed, partakes greatly of the nature of speculation. Before the question of "improved" as against native ploughs can be settled for India, there must be actual demonstration of the superiority of the crops grown by one method as against those by the other.

Trials of native and improved ploughs

I am well aware that deep ploughing has been advocated by Mr. Benson and others of great experience in India, and also that some

Swedish ploughs here. Those used on the black soil go 1 foot deep, and require six to eight pairs of oxen, they cost Rs 50 each, but a smaller size used on red soil costs Rs 25 only. One thousand ploughs in all, have been sold, the repairs, however, are all done at Mr. Sabapathi's factory. Mr. Saharayagam Mudhar, at Shyali, also has his own workshop, where repairs can be executed. Messrs Thomson and Mylne, who make the Beheca sugar mill, have found this same difficulty of repair, and have met it by establishing local depôts, taking back the worn out mills from the cultivators, and replacing them by new ones, in preference to trusting to local attempts at repair. The manufacture of wooden ploughs, again, is a regular employment of the village carpenter, he forms part of the village community, and does not charge for his labour, but is kept up at the general expense of the villagers. At harvest time he gets a proportion of the grain, and, in return, repairs and makes new ploughs all the year round. His occupation would be in great measure gone were iron ploughs substituted for the wooden ones.

There is yet another objection. The *rayat*, if he be given a furrow-turning plough, will not use it as it ought to be used, *viz*, allowing it to run flat on the sole, but he will stick the point into the ground, just as he does with the native implement, and the work will be both faulty and difficult to manage. It was at Nadiad that I saw a Native working with the 'Saidapet' plough, the front wheel was quite up in the air, and never ran on the ground at all. I saw the same done at Seebpore, with a plough introduced by Mr. Sen, but, when the man was shown how to use it properly, the work was very good.

Until the foregoing objections, notably the first and third (cost and difficulty of repair), are met, I do not think that iron ploughs will be used to any considerable extent.

278 Even if properly used, a plough that goes deep may do harm where a native one would not, *viz*, by turning up inferior soil, and by bringing lumps of limestone (*tankar*) to the surface.

Again, it is quite possible that were deeper ploughing to be in vogue, the moisture, which, in the case of some soils, it is so necessary to retain, might be lost. The turning over of a furrow

more like that of a pointed stick running through the ground, just below the surface, say 2½ to 3 inches deep, simply stirring and loosening it. For hard and sun-baked ground, such as is often met with, no action could be better adapted, and, in a trial at Meerut, I saw an English plough completely fail on such land.

I have Mr W B Hudson's (Tirhoot) authority for saying that for breaking up land in wet weather the native plough is better than a furrow-turning one, for the latter throws over a slice which will not break down readily.

4. The Native will not use an iron plough in the proper way.

Objections to deep ploughing in India.

281. There are cases, however, where "improved" or English ploughs may be profitably used. This will be, I think, only where there are large areas to be cultivated, time being thus a matter of importance, and the economy of quick labour and improvements having room to show itself, so that the question of first cost becomes relatively of no importance for the adoption of planters of Behar over-hear that he likes the adopting it on his estate.

Cases where "improved" ploughs may be used profitably.

Both Mr. Sahapathi Mudliar, at Bellary, and Mr. Sabanayagam Mudliar, at Shiyali, are large landed proprietors, and I could understand the advantage to them of the "improved" ploughs. The latter gentleman had 287 tillage cattle, and he reckoned that he could do 13 acres with the "improved" plough in the time that the native wooden plough was doing 4 or, at most, 5 acres. So this meant to him an economy of cattle.

In Behar I have seen even and Mr. W. B. Hudson told to plough with it about half to bring a fresh layer of soil into use. Again, at Captain Chapman's estate at Bâti, Oudh, I saw a steam-plough at work. The "cultivator" was employed for the purpose of breaking up land and bringing it under cultivation. The land had previously formed the bottom of a lake, and such a matting of weeds and roots I have seldom seen. The steam-plough had as hard a task set as was possible to imagine, but it did its work splendidly, and by side was other land which had before been in the same state, but now, mainly as the result of steam-ploughing, was bearing magnificent crops. Had not the well known zeal and energy of Captain Chapman brought the resources of improved machinery to bear on this land, it would be unreclaimed still, for I am sure that no implement other than the steam-plough could have possibly done the work.

cc, The steam-plough.

There are yet other cases in which I think an iron plough might do good. When land is clean and free from weeds such as *Lunda* (*Saccharum culare*), the turning over of a furrow would bury the stubble, so as to allow it to rot and serve as manure to the land. In

iron ploughs useful on clean land.

held was left very even and clean. If there be nothing but stubble and harmless weeds, the turning in of these would enrich the soil by the added manure provided in the decomposing stubble and grass, instead of wasting it as the native plough would. If, however, the weeds were of such a nature as to spring up again after being buried, the harm done by inverting the soil and covering them in would be much greater than the benefit received manually.

In preparing land for sugar cane, a Native will plough 8, 12, or even 20 times, in order to get deep enough, and to render the

iron ploughs useful for sugar-cane.

soil fine enough. Here I am sure that deep ploughing at the first would effect a great saving of labour. The possible loss of moisture has not to be considered, for sugar-cane is almost universally watered artificially. As a matter of fact, in the sugar cultivation around Poona it is the practice to plough 7 inches deep with an 8-hullock plough.

Lastly, it sometimes happens that, when heavy rains come on suddenly, the surface soil may get super saturated and water-logged, the lower layer remaining firm and dry, whereas, had the soil been deeper ploughed it would have retained the water better and have allowed it to sink in to a greater depth, instead of soaking merely the surface soil, and then running off.

282. If for ploughs of new designs there be but little room, still less is there for more expensive implements, such as seed-drills, mowers, reapers, threshing machines, etc. The native seed drill will strike every one who sees it at work as being woefully inefficient, and leaving little to be desired. At the Saidapet Farm
at a cost of Rs. 100
implement, won 100

I can, however, understand that when one watches the slow process of reaping a crop, a number of men (and often women too) squatting down, cutting handfuls at a time, laying them in bundles, and then leisurely taking these home, he will naturally think that a mowing or reaping machine would pay better in the end. But it is far otherwise, for the machine is
injuring the crop, and the
and very much more cheaply

experience shows that, even in England, when labour falls below a certain level, it does not pay to use machinery, and reaping by hand may still under some conditions be more economical than by machinery. So is it with threshing machines, the cultivator has his hullocks, they may as well work and tread out the grain, he has no fear of bad weather coming, and no urgent call on his time, nor hired labour to pay, besides, he gets the broken straw and chaff (*bhusa*) soft, so that his hullocks will eat it readily. At the Cswnpore Farm there is a threshing machine the price of which is Rs 188, but it is almost needless to say that none of this kind have as yet been sold.

283 Threshing machines and winnowers, however, demand somewhat more attention, by reason of the importance attaching to the cleaning of grain, more especially that of wheat. It is only on large estates, the "concerns" of indigo planters, and by Europeans generally, that threshing machines will have any actual use on the farm itself, and then it will be because in such cases there is a great deal to thresh, labour is
is thus an object in view
break and chip the wheat a 1/2
gram from wheat, and that the *bhusa* is not rendered short or soft, as it is by the process of treading out with hullocks

Inasmuch as the planter grows his oats, barley, or other grain

Iron ploughs
useful when
rain is very
heavy

Little scope for
use of seed
drills mowing
and reaping
machines
threshing
machines etc

Threshing
machines and
winnowers

Their limited
use

not for export, but for use on his estate, the objection as to the appearance of the sample does not matter to him, and he feels, too, that his cattle, after a short time and on getting used to it, will perfectly well eat the straw thrashed by the machine. However, to meet the objection (one, I think, based on custom and idea only), in some modern threshing machines an arrangement for softening the straw has been added. Winnowing machines have met with more favour from the cultivator than have threshing machines, and he is ready, I think, to admit their usefulness.

is of no consequence, and some experiments conducted by Mr. Finacane tend to show that treading-out of corn by bullocks is more economical than steam. It may be said generally, is not required, cattle-power

284. Anyone who has watched the clever devices of the native cultivators in the implements which they use for harrowing, leveling, drilling, raising water, etc., will see that if anything is to replace the existing implements it must be simple, cheap, and effective. He will indeed be a clever man who introduces something really practical. I was especially struck with the effectiveness of a small hand-pick, in common use for digging holes to put seedlings into. Another useful implement is the *kodali* or hoe, I have heard indigo planters say that, if they could afford it, they would prefer to have their fields broken up with this hoe rather than with any kind of plough. The Native raises the *kodali* above his head and brings it down with force into the soil. It penetrates about 4 inches, and brings up the soil in large blocks which are left to weather down. *Dab* grass (*Cynodon Dactylon*) can be exterminated in this way.

A short-handled hoe, called, in some parts, a *mamdi*, is in general use also, and is a most handy tool. I was very pleased,

men are piled upon the sledge, and it is safely dragged by bullocks over fields and roads, however rough, and sometimes to considerable distances.

In speaking of attempts made at improving native implements, I am reminded of a story which I heard about a man who tried to introduce spade digging into India. Hearing that the Native did not wear shoes, he had a broad piece of iron fixed on to the spade, so that the foot might be put on it more easily, but he quite forgot that the Native never uses his legs or feet for driving anything into the ground with force, but does so entirely with his

Cattle power
at least
power cost
less

Native implements
are effective

Improvement
must be
rational

arms. It is useless to try to make the Native do anything of this kind except in his own way. Take, for example, the case of men mending a road and shovelling stones on to it, they do not work as English labourers would, but one man holds the handle of the shovel while another pulls at a rope fixed on the lower part of the handle just above the iron. In this way the stones are scraped up on to the shovel and deposited where wanted. It is the same with ploughs, a Native if given a double handled plough, would naturally conclude that it was meant to be guided by two men, one at each handle.

Improvement in implements has been effected

285 Ingenious though native implements be, and hard though they be to improve upon, there are, nevertheless, instances to show that here and there it can be done. These I proceed to consider.

Implements sold at the Cawnpore Fair.

286 At the Cawnpore Experimental Farm several kinds of implements are manufactured and sold yearly. In 1888-89, 34 ploughs ("Watts" and "Kaisar"), 22 pumps, 24 corn grinders (costing Rs. 25 each), and 8 chaff cutters were sold at the Cawnpore Fair. Sometimes implements are given out on trial, but most are sold outright.

The Cawnpore pump

The pump sold here is generally known as the "Cawnpore pump." It is a kind of chain pump, and is admirably suited for raising water the depth of which below the surface does not exceed 20 feet. The pump has had considerable success in the neighbourhood, though it hardly comes within the *rayat's* means, the prices are, for 3 feet to 10 feet depth, Rs. 40, for 15 feet depth, Rs. 45, and for 20 feet depth, Rs. 50. This pump is an adaptation from one brought by Sir Edward Bock from Australia. After a long series of careful trials and modifications, made under the supervision of Mr W. J. Wilson, of the Irrigation Department, North West Provinces and Oudh, it was found that for depths between 15 feet and 20 feet, the pump was more effective than any other device for raising water. It is, therefore, a very valuable addition to the list of implements for raising water. It is, therefore, a very valuable addition to the list of implements for raising water.

Sugar-mills

287 The success that has attended the introduction of iron sugar mills has been touched on in passing (see paragraph 276). In many parts they have quite replaced the old clumsy native wooden mills. The native mills are either the *kolāu*, a mortar and pestle arrangement, in which the cane is bruised and pressed, or else wooden roller mills, of which there are two kinds, the *gundā* or *charkā*, consisting of two, or sometimes three, upright wooden rollers, arranged in a horizontal line, and driven by a single wheel. The *gundā* is a very simple machine, and is used in many parts of the country. The *charkā* is a more complicated machine, and is used in the more advanced parts of the country. The *gundā* is a very simple machine, and is used in many parts of the country. The *charkā* is a more complicated machine, and is used in the more advanced parts of the country.

are, that they can be made into a rope, and that the cane does not have to be chopped up or cut into short lengths, as is the case with the *kolāu* and with the iron mills, thus, the fibre, after pressing, is available for rope-making, and especially for ropes for wells. For

the latter purpose the sugar-cane fibre is much prized, as it will stand the constant immersion in water necessitated by the employment of the Persian wheel, the method of raising water most common throughout the Punjab. Still, it has been rightly pointed out that there are quantities of *munj* grass (*Saccharum ciliare*), which would serve the same purpose quite as well.

288. Anyone possessing a knowledge of the chemistry of fermentation is well aware how great may be the gain or how great the loss resulting from attention to or neglect of the numerous, and often seemingly minute, points which affect the condition of fermentable substances, such as the juice of the sugar-cane. Cleanliness, rapidity of expressing, speedy transference to evaporating-pans, rapid boiling, extent of surface exposed, removal of non-crystallisable matters, proper desiccation, and final careful storage, are considerations which favourably influence, in a most marked way, the out-turn from one and the same quantity of original material worked upon. There are a number of other determining factors, such as, the variety of cane grown, the method of cultivation, the manuring given, the influences of soil, weather, and watering, the time of cutting the canes, and the rapidity with which the canes are taken to be pressed. On all these matters knowledge in India is not limited, and a wide field is still open for enquiry. On one or two points there is some general knowledge, as for instance, that the quicker the juice be expressed, and the more cleanly the process be, the larger will be the actual yield of sugar. In these respects the Beheer sugar-mill and its imitators show great improvement over the native methods. The iron mill has also the advantage of being portable, and it can be worked by the labour which the *raiya* can command. The Beheer mill was introduced in 1873-74, and, as first manufactured, was a two-roller one, costing from Rs. 80 to Rs. 100, but within the last

Circumstances affecting the col torn of sugar

Need of scientific enquiry

Advantages of the iron sugar-mill over the native mills.

pressing rollers. I have spoken of the difficulty attending the repair of the iron mill, and how the proprietors, Messrs. Thomson and Mylne, have met this by establishing depôts throughout the country, where worn-out mills can be replaced by new ones.

The careful and prolonged study of what the Native really requires has, in this instance, resulted in the production of a machine the advantages of which have been clearly grasped by him; hence the progress made.

289. I give the following instances of the extension of the use of the iron sugar-mill —

Instances of extension of use of iron sugar-mill

The Punjab Administration Report (1889) speaks of the Beheer sugar-mill and its modifications as being "the only implement successfully introduced into the Punjab in late years." In Rohilkhand it is "driving the old *kolhu* (native mill) out of use", in Kapurthala the substitution of it for wooden mills is actively encouraged. At first the cultivators would not take it, but when, in 1886, as the result of competition, the price came down first 80 mills were purchased, and later on 200 more. There is abundance of *munj* grass (*Saccharum ciliare*) at Kapurthala to serve for well ropes. In

1 Punjab.

Hosharpur the iron mill is coming into use the native mill (*belna*) is worked by three pairs of bullocks and the cane has to be passed through the rollers several times

3 Bengal.

From Bengal there are many reports of the extension of the use of the iron mill, e.g., in Lohardaga Palamu and Rungpore. In Palamu the native *kolhu* has been driven out of use and in Rungpore, on one Estate (Balashan) alone there are 300 iron mills in use

3 Madras

At Hospet in Madras, I found that 75 Baheera mills had been sent there between January and August 1884 alone. Mr Goud, of Hospet has since pushed the sale of iron mills largely, and they are highly appreciated there are now 600 Baheera mills in the district, and the wooden mills are all gone. The iron mills are hired out for one rupee per day. Mr Goud told me that there is a large field for iron mills in Hyderabad, as the people have not yet given up their wooden mills

4 Bombay

From Bombay it is reported that in one village alone viz, Veler in Valva taluk Satara there are 120 iron mills in use. The mill is pushing its way in the Deccan but in Gujarat, with few exceptions, the wooden mill still holds sway

5 North West Provinces

It is in the North West Provinces that most advance has been made, and iron mills are almost general. The Baheera firm have depôts at Saharanpur and elsewhere

Respective merits of rival iron sugar mill

Work for Agri cultural Departments

Shallow evaporating pan.

290 It is not for me, without special investigation and trial, to go into the respective merits of rival iron sugar mills, but I would say that these are legitimate points for Provincial Agricultural Departments to enquire into. Experimental Farms are places where such trials should be exhaustively carried out

291 Passing from the sugar-mill, I would next mention to implement the extended use of which would be attended with much benefit, I mean the shallow iron evaporating-pan for boiling the expressed cane-juice in. The more rapid evaporation effected by the broad shallow pan, as against that with the narrow and deeper pan generally used, would give much less opportunity for secondary fermentations setting up, and for impurities finding their way into the juice. Both of these circumstances will cause a loss in the amount of crystallisable sugar yielded. In Palamu (Bengal) the shallow pan is in use but not in Lohardaga, nor yet in Dacca, in the latter earthen pans are employed. In Gujarat (Bombay) the use of the shallow pan is universal but it is not known in Bassein where deep narrow copper pans are in vogue

Sugar turbine "

292 Still more recently a centrifugal "drier" or sugar "turbine" has been introduced into India, it effects the rapid separation of the molasses from the crystals of sugar. Though worked by hand and very efficient, it is of necessity expensive, and cannot as yet be expected to be applicable except where sugar is made on a tolerably large scale or by a combination of *rayats*. A sugar "turbine" of 36-inch size will deal with 50 maunds of crude sugar in 10 hours

Other implements

293 Ploughs, winnowing machines, and iron sugar mills are about the only implements which the Natives have in any way appreciated, and, among these, the success of the last named has been much the most marked

Of other implements, I must say that it is not likely that they will enter to any extent into the *rayat's* agricultural system

Chaff-cutters may, perhaps, be here and there appreciated, and a few have been sold at Cawnpore, so, too, may it be with corn-grinding machines. Others, such as bone-mills, water-pumps driven by wind, cream-separators and other dairy implements, mowing, reaping, and threshing machines, elevators, cotton-presses, etc., will only be employed on large Estates, on Grass Farms, or in connection with towns.

I can, however, indicate one implement of which there is need; this is a portable oil-pressing mill. At present the mortar and pestle arrangement adopted in the native wooden oil-mill, though effective, is cumbersome. Its cost is Rs. 60. In consequence, all the oil-seed has to be brought to a place where there happens to be a mill. What is wanted is an oil-mill of a domestic size, which a woman can work inside the enclosure of her own house. A way seems open for some one to replace the present oil-mill with some such machine as that with which Messrs. Thomson and Mylne supplanted the wooden sugar-mill.

A portable oil-mill wanted.

294 But improvement in implements, or rather in the cultivation by their means, need not always proceed from outside existing Indian practice. Sometimes it may be found that in a particular district an implement is unknown, or is inferior to one in use elsewhere, and improvement may be effected by the transference of practice. At a little distance from Ferozepore, on the way to Ludhiana, Mr. E. B. Francis showed me some light sandy land on which when a shower of rain falls soon after sowing a crust is very apt to form, so that the young shoots cannot force their way through it. This is especially the case with barley and rather less with wheat, when it forms, the people habitually re-sow the crop, for they have no implement corresponding to a harrow. I have instanced how careful the Behar indigo planter is to break up this crust the instant it forms, using a bullock-rake or harrow having spikes some 8 inches long and penetrating about 2 inches into the soil. An implement of this kind if introduced at Ferozepore would entirely dispense with the necessity of re-sowing. The improvement here would consist in a transference of native methods, not an importation of foreign ones. A similar instance is that of a seed-drill for "dry" (unirrigated) cultivation. In the northern or Telugu portion of Madras such a drill, is used, but not in the southern or Tamil portion, where the grain is sown broadcast on "dry" land.

Improvement by transference of use of native implements

295. Experimental Farms have in some cases been, and ought to be still more the places where different implements should be put to thorough tests. Subsequently they might be the centres for distribution of such implements as had been found to be really beneficial, and which the *raiyat* would be able to avail himself of. But much more care must be exercised, I think, than has been given in the past before a machine goes out with the Farm's imprimatur on it. If it be found to be useless, or if it be beyond the *raiyat's* reach, it will not redound to the Farm's credit, nor to that of the Agricultural Department of the Province. I have seen at Experimental Stations implements which there was not the remotest chance of the *raiyat* ever using, and, unless these are really required

Trials of implements at Experimental Farms and distribution of implements by them

Need of greater care than in the past

for the economical management of the Farm, their presence for demonstration purposes is a useless expense

Desirability of
associating men
of scientific
attainments with
agricultural
enquiries

296 In conclusion I would remark on the desirability of employing in agricultural enquiries men of scientific attainments, such as engineers, chemists, botanists, geologists, etc, whichever the circumstances of the case demand. If this be not done, such experimental trials will lose the greater part of the value that might attach to them, and there will be no guarantee as to their being properly, that is, scientifically, conducted. On the other hand, real value may be derived from such experiments when carried out on a right system and with scientific help. It is most desirable therefore that Agricultural Departments should employ in their enquiries the aid of skilled experts.

CONCLUSIONS

CONCLUSIONS

297. In considering the differences of agricultural practice which arise from the possession, in one district, of implements unknown in another district, we have passed entirely beyond the second main division of differences laid down in Chapter II. No longer do external surroundings enter, but it is altogether with the third division that we have to do, *i.e.*, the differences which arise directly from want of knowledge.

On this account the people can do little or nothing to effect improvement, while from the peculiar conditions of Indian agriculture, the Government cannot do much either.

In brief, I do not think that there is any great scope for improvement in the *rayat's* farming implements.

Further, where any improvement is possible, it will come mainly from without and not from within, *i.e.*, by the application of Western science to native ways and requirements. Very occasionally only will it be possible to extend the use of a native implement already in use in one part but unknown in another.

The introduction of the Iron Sugar-mill has, however, clearly shown that marked benefit may arise from the employment of machinery of Western origin provided this be carefully adapted to the needs of the Native. Unless this provision be taken failure will certainly result.

Similar benefit may result from the use of shallow evaporating-pans for sugar-boiling, and there is an opening for a portable oil-pressing mill.

Although in some instances deep ploughing is advantageous, this is not generally the case in India, and I do not think that iron ploughs will take the place of the native wooden ones until the difficulties as to initial cost and repair can be met.

For winnowing machines, chaff-cutters, and *crushing* rollers a limited future may be open, but other implements, such as mowers, reapers, threshing machines, elevators, *bone-mills*, *crush-separators*, etc., a use will only be found on large *Estates*, *Crush Farms*, or in towns.

The work of Government in connection with the introduction of new implements is to submit them to exhaustive trial at Experimental Farms and to work them side by side with the native methods.

If the advantage of a new implement is clearly demonstrated, then the Provincial Agricultural Department should make its Farm the centre from which to distribute the implement and its Shows the means of exhibiting the machine at work

In conducting any exhaustive trials the Provincial Agricultural Departments should make use of experts in the particular branches of science connected with the enquiry.

RECOMMEND- ATIONS.

RECOMMENDATIONS

298. I recommend —

The exhaustive trial of new implements at Government Experimental Farms.

The association in trials of Implements of men specially skilled in the respective sciences concerned in the enquiry

The distribution of approved Implements from Government Farms and the utilisation of Agricultural Shows for demonstrating the working of such Implements.

CHAPTER XIII.

CHAPTER XIII.

CROPS AND CULTIVATION.

CROPS AND
CULTIVATION.

299. A DESCRIPTION either of the crops of India or of their cultivation is not called for in my Report, and I shall therefore only deal with these matters in so far as any suggestion for their improvement can be made. Scope of this chapter.

300. I have remarked in earlier chapters upon the general excellence of the cultivation; the crops grown are numerous and varied, much more indeed than in England. That the cultivation should often be magnificent is not to be wondered at when it is remembered that many of the crops have been known to the *raiyats* for several centuries; rice is a prominent instance in point. Yet, that improvement is not impossible may be seen in the spread, within recent times, of indigo and jute cultivation, the introduction of tea-planting, the raising of the potato and other vegetables, the growing of maize, etc. Possibility of improvement.

301. The increasing demands of other countries for wheat, Changes produced by export.

for manure and his labour, as well as straw for his cattle, the element of export has now entered into his calculations, and has marked changes in the kinds and extent of the crops grown.

Thus, in the Punjab, in the year 1888-89 alone, an increase of 11 per cent. was recorded in the area devoted to wheat-growing, no less, than 54 per cent. of the *rabi* or winter-cropped portion, or 31 per cent. of the whole cropped area of the year, being now taken up by this cereal. Increase in wheat area.

In the Hoshiarpur district, sugar-cane is no longer considered the best-paying crop, but its place has been taken by wheat, sugar-cane coming next in importance, and then cotton.

302. In the preceding chapters much has been said in regard to improvements which can be effected Review of improvements.

rules, would enable larger crops to be grown, and that the better

The present
chapter

conservation and increased supply of manure, the provision of "Fuel and Fodder Reserves," the growing of fodder crops, the better breeding of cattle, the adaption of certain implements, and other means, would directly improve agriculture. I will not refer again to these methods in the present chapter, but will confine myself to a consideration of possible improvements not already treated of, and which are of a kind more nearly connected with the individual crops themselves. Such improvements are those which may result from the practices of fallowing, rotation, selection and change of seed, or from the introduction of new crops or new varieties of crops, the extended cultivation of particular crops, and so forth.

Fallowing
not a practicable
remedy

303 When discussing, in Chapter V, the question as to whether the soil of India is becoming exhausted or not, I referred to the practices of Fallowing and Rotation (see paragraph 49). The more special treatment, however, of these subjects comes in here. Fallowing is quite well known to the Indian cultivator, and its value is understood, but the practice of it is greatly reduced by the pressure of population on the land, and by the increasing demands made upon the soil. The instances cited in paragraph 40 bear testimony to this, although the evidence also shows that the *rayat* will fallow his land if he can afford it. In some of the cases quoted, a prolonged fallowing and renovation of the land was effected by allowing it to revert to its original state of forest and jungle, and then after a time, clearing it, sowing, pressing and cultivation.

The *rayat* will do it, as I have said,
do it if he is obliged

221

Mixed crops

304 It is quite a mistake to suppose that Rotation is not understood or appreciated in India. The contrary is the case. Frequently more than one crop at a time may be seen occupying the same ground but one is very apt to forget that this is really an instance of rotation being followed. It is not an infrequent practice, when drilling a cereal crop, such as *gaur* (*Sorghum vulgare*) or some other millet, to put in at intervals a few drills of some leguminous crop, such as *arhar* (*Cajanus indicus*). The grain crop grows the more rapidly and keeps the other back, it is duly reaped when ripe and the land which it occupied is then ploughed. The pulse crop thus free to extend itself, grows on apace, spreading partly over the intervening area and becoming the crop of the field, until, in due time, it too is reaped. The next year the same "mixed crops" may be sown again, and thus to the casual observer it might appear that continuous cropping was being practised. This, however, is not so, for there is a perfect rotation of cereal and legume. This is, perhaps, the simplest form of rotation, but there are many more complicated than that of "mixed cropping." The latter, however, has the advantage of providing against the fluctuations of season, for, should one crop from any

Advantages of
mixed
cropping

reason fail, the other will probably stand and cover the ground. This is a matter of no small moment, seeing that a *rasyat's* entire holding is only few acres in extent, and that it has to feed him, his family, and his cattle, and to pay the rent as well. In an experiment made at the Bhadgaon Farm it was found that a greater profit was obtained by intersowing cotton with *jadr* or *arhar* than by growing the cotton alone.

"Mixed crops" are not confined to two in number on the ground at the same time, but several sorts may be sown together, for instance, wheat, barley, and gram (*Cicer arretinum*), or these with rape (*sisson*) as well. Wheat and gram often occur together, so also wheat and linseed, the latter frequently fringing the wheat field, and thus serving to keep cattle off, inasmuch as they will not touch the growing linseed. Cotton with *jadr*, cotton with *arhar*, and wheat with mustard, are other instances of "mixed crops." There are many systems in ordinary use which are far more complicated than the above. For instance, not only may there be the rows of crops side by side, as noticed above, but the alternating rows may themselves be made up of mixtures of different crops, some of them quick growing and reaped early, others of slower growth and requiring both sun and air, and thus being reaped after the former have been cleared off. Again, some are deep rooted plants, others are surface feeders, some require the shelter of other plants, and some will thrive alone. The whole system appears to be one designed to cover the land, and thereby to prevent the bareness and consequent loss to the soil which would result from the sun beating down upon it, and from the loss of moisture which it would incur. It is known also that the process of nitrification in soils is much more active when a growing crop is on the ground than when the latter lies fallow.

305. In most parts it will be found that, whilst rotation is practised, no regular order in the crops forming a rotation is kept to, but that considerable latitude is exercised in their choice. Nevertheless, the crops will generally be found to follow certain rules of rotation, such as cereal after legume, and fruit-bearing crop after bulbs. The one crop with which rotation is not practised is rice.

Why this should be so may be better understood when the conditions under which rice is grown are considered. Rice flourishes on silt-renewed lands that need little or no manure, and which are plentifully supplied with water. The water itself, by its constant renewal, probably makes the soil-constituents more readily available. Under these circumstances the rice plant becomes semi-aquatic in character, and is more independent of manure, and of the manurial benefits effected by rotation. Differences in the mode of cultivating rice may, however, be followed, thus, in some parts of Bengal it is the rule to sow rice broadcasted one year, and transplanted the next.

Rotation

Rotation not practised with rice

Instances of
Rotations
practised.

306 The following are instances of Rotations practised in different parts —

1 Panjab

In the Panjab —

On "dry" (*barani*) land On rich land *

Fallow	Cotton	Wheat or barley, with gram
Wheat and gram	<i>Senj</i> (a millet)	and oil seeds
<i>Chari</i> (fodder <i>juar</i>)	Sugar-cane	<i>Juar</i> or <i>bajra</i> with pulses
Fallow	Maize	Fallow
Fallow	Wheat	Fallow
Wheat and gram	Cotton	Wheat or barley (as above)
<i>Chari</i>		<i>Juar</i> or <i>bajra</i> (as above)

2. North West
Provinces

In the North-West Provinces —

Indigo	Millet
Barley and peas	Fallow (Green crop ploughed in)
Fallow	Wheat or other winter cereal
Wheat.	Millet

3 Bengal.

In Bengal —

In Lohardaga on uplands

- 1st year, *marua* (a millet)
2nd , *gara* (rice)
3rd , *rid* (pulses)
4th , *gondli* (millet), followed by an oil seed or pulse

In Palamau

(a)	(b)
1 Cotton	1 Maize or some millet.
2 Gungelly (oil seed)	2 Wheat for two or three years
3 <i>Kodo</i> (millet)	3 A leguminous crop for a year or two

In Dacca

(a)	(b)
1 Potatoes	1 Jute
2 Peas or jute	2 Tobacco or a pulse crop
3 Chillies	

In the instance from Lohardaga there is a four years rotation, giving five crops of which three are cereals. In Palamau the same cold season (*rabi*) crop whether cereal or pulse is never grown on the same land for more than two or three years successively, but it is always followed by a *rabi* crop of a different character or growth.

In the Central Provinces —

Juar, *kodo* (a millet), and *arhar* (pulse) sown together

Wheat

4 Central
Provinces.

5 Bombay

In Bombay —

In Gujarat

- 1 Cotton
2 Wheat or *juar*
3 Gram or some pulse

In Surat

- 1 ~~San~~ hemp ploughed in and fol
lowed by sugar-cane
2 Sugar-cane
3 Rice with *arhar* or some pulse
4 A pulse crop

In Mahim

- 1 Betel vine, two years
2 Ginger.
3 Sugar-cane
4 Plantains, two years.
6 Rice or *ragi* (*loc nagli*), on *rabi* seed bed.

In the Konkan, on hill land

- 1 *Nagli*
2 *Warai* (a millet)
3 Niger seed (oil seed), then fallow for five to six years

A general rule in "garden land" rotation in Gujarát is —
 "Tap-roots follow fibrous," and that which bears fruit should follow "bulbs."

The rotation instanced at Máhum is a seven years' course on "garden-land," but another, of five years duration only, is made by the omission of betel vines, and is also practised largely

In Madras —

C. Madras

In Coimbatore, though there are variations caused by early or late rainfall, a frequent practice on "dry" land is to sow *cholum* (*sorghum vulgare*) or

In Tinnevely, cotton succeeds *lambe* (millet) and pulses, it is sown with the cereals, and remains after that crop is reaped

307. Sufficient proof has now been given that rotation of crops is both understood and practised. Whether the rotations are of the best kind, or whether they might be improved upon, is another matter, and one upon which my limited knowledge of the crops and their habits does not allow me to give an opinion. I have frequently read statements as to inferior cultivation being the result of injudicious rotations, but I have seldom seen any suggestions as to what should be done instead. Much must depend on the climate, the nature of the soil, the facilities for water and manure, etc. In England the use of artificial manures enables great liberties to be taken with rotation, and may even cause it to be partly suspended in case of the market favouring the growing of a particular crop. In the same way it is more than likely that the *rayat* will, in general, be the best judge of what his land can do.

Improvement
of Rotations.

308. Though the *rayat* may have little or nothing to learn about rotation, he is very ignorant in regard to selection and change of seed. In this respect the Indian cultivator might well follow the European planter, as, for example, in the careful selection of indigo seed. Even in Gujarát (Bombay), where the indigenous cultivation is excellent, the benefit of selection and change of seed is not appreciated; throughout Bengal it is unknown, except in the case of indigo. The Hoshiarpur (Punjab) Settlement Report says: "It is to be regretted that the cultivators should ordinarily exercise so little care in the selection of 'seed for their crops.'" The Rawal Pindi Settlement Report speaks of the absence of careful seed selection by the cultivators. The same neglect is shown in the Central Provinces; both here and elsewhere this is especially the case with cotton, indeed, the complaint that the long-stapled varieties, such as Broach, are deteriorating, is traceable to the want of selection of seed, or rather to a mixture of seed being given to the cultivator to sow.

Selection and
change of seed

Not generally
practised

There are several proverbs, such as one which Mr. Benson found current in Kurnool, pointing to the desirability of selecting seed. "As you give gifts to the deserving, so select

"seeds for your soil," runs the proverb, but the practice is different to the precept, and seed is not habitually selected.

Now and again selection of seed is practised to a certain extent. Thus, in the Rawal Pindi Settlement Report, Mr. F. A. Robertson points out that the Arams or Malliars are the best cultivators, and that they select their maize seed. The crop is, in consequence, far superior to that grown by the other cultivators. He adds, "What is wanted is careful selection of seeds by the cultivators, and the fostering care displayed by the Malliars in bringing their crop to maturity."

At Hoshiarpur I found that, when *judr* was grown as a fodder-crop, fresh seed was obtained every year from another district, viz., Ludhiana.

It is very certain that if more care were taken in the selection of potatoes for seed, and in change of seed, the crop might be greatly improved.

309. The root of the mischief lies in the system by which the cultivator is not his own seed merchant, but is entirely dependent on the *baniya*, *mahajan*, or similar individual of the money-lending class. These men supply the *rayat* with seed, charging interest at an exorbitant rate, for they know that he *must* have seed or else he cannot grow his crop. The accounts between merchant and cultivator, thus begun over seed transactions, are seldom allowed to lapse, and often assume enormous proportions, leading to mortgaging of land and other evils. It is in this that the utter improvidence of the *rayat* is shown, and that he frequently becomes a prey to the money-lender. Having saved no seed for himself for re-sowing, and having no money to purchase elsewhere, he has recourse to the means so ready at hand, and the land is practically charged with an extravagant burden, and one of the *rayat's* own creation. It is strange, indeed, what a hold the money-lenders have on the people; in one district of the Central Provinces I found well-to-do cultivators, who could easily have purchased their seed in the open market or from other cultivators, but who, nevertheless, went to the *mahajan* for it, because they liked to be on good terms with him; so they regularly borrowed from him, and paid him back at the end of every half-year.

Mr. Fuller, in one of his Reports, says, "Borrowing seed-grain is incompatible with improvement by seed selection," and this is strictly true. But the practice has become almost universal, and the *mahajan* is a regular institution, so that improvement cannot proceed to any great extent unless by an alteration in the *rayat* himself.

In the case of cotton, the cultivator sells both fibre and seed, and the grain merchant, receiving many small lots of seed, often of different varieties, mixes them up together. Later on, the grower buys back the mixed seed and sows it, and, thus, purity of seed and uniformity of quality are altogether lost.

The cause of the neglect

Money lenders.

Improvidence of the rayat

Cause of deterioration of cotton

310. As the *raiya*t, even under the best of circumstances, can hardly free himself from resorting to the money-lending grain merchant, because he has nowhere else to go for his seed supply, it becomes one of the most useful acts which Government can do, to provide the cultivator with seed, or rather, with the facilities for obtaining it.

Selection and distribution of seed by Government at Experimental Farms, etc

The business of a seed merchant, as understood in Europe, is unknown in India, and I do not think that there would be any scope for it, even if it were desirable to introduce it. But Government, by means of its Farms, might serve a most useful end in growing pure seed and in making it available for distribution to cultivators. This has not been altogether neglected in the past, and the Cawnpore Farm of the North-West Provinces especially, and also the farms of the Bombay Government, have done good work in showing the advantage of selection and change of seed, and in the establishment of distributing centres for good seed. But much more extended action is required before the cultivator can be rendered independent of the grain merchant. The Farm at Cawnpore cannot now supply enough seed to satisfy the demands made upon it. There ought to be not only Experimental Farms, but Seed-growing Farms, where the *raiya*t could buy pure and good seed at a moderate cost, instead of, as he does at present, going to the *bazar* and getting what he thinks looks best. If the experiments at some of the Government Farms were curtailed, and more land were laid out in producing selected seed for distribution to the district around, I think more good might be done. This work does not imply the existence of a distinctly *experimental* farm, nor of a skilled staff, but there might well be, under Provincial Agricultural Departments, a Seed Farm in each district to provide for the requirements of that district.

Good work already done

Extended action needed

The Bombay Agricultural Department distributes seed in Sind to *semdars* on the simple condition that the amount of seed given is subsequently returned to Government.

At Nadiad the local Agricultural Association has established a seed store in the town, for the sale of selected seed at cost price. The plan is slowly making way with the cultivators.

Court of Wards' Estates, again, would be very suitable places at which to grow selected seed, and they might act as distributing centres for the supply of seed to the neighbourhood.

Not only must the seed itself be available, but encouragement and facilities must be given to the purchase of good seed. The system of *taccari** advances is applicable to the case of seed-purchase, equally as to the digging of wells and purchase of cattle. But in the case of seed, advances are given only in time of scarcity, and not in ordinary times. There would be no need of such restriction if Government became the grain supplier. As long as the cultivator resorts to the money-lending grain merchant, the working of *taccari* advances

Facilities should be given for purchase of good seed

for purchase of seed will be unsatisfactory, but if Government were to supply the seed from their Farms or from other distributing centres, the cultivator might be freed from having to resort to the *banya*. In other words, Government might practically become the *banya* themselves

Introduction of
new varieties.

1. Wheat

311. Improvement may be effected not only by selection and change of seed, but by the introduction of new varieties. Experimental Farms have, in this matter also, done very useful work in showing what new varieties are likely to have any permanent value, and in some cases considerable benefit has accrued from their distribution. At the Cawnpore Farm other varieties of wheat than those in local use have been tried, the Muzaffarnagar variety, in particular, meeting with considerable success. Thus in 1888-89, about 40,000 lbs of Muzaffarnagar wheat were distributed, and over 7,000 lbs. of seed oats. The Bombay Agricultural Department also does a very considerable work in trying new varieties of seed. The 1888-89 Report states that a soft white variety of wheat from the North-West after acclimatisation, was distributed to 65 *zamindars* in Sind. It proved very successful, and 2,815 acres in the Nara Valley (being one-eighth of the total wheat area) had been sown with it. It is found to ripen quicker, to yield more grain and more straw, and to be less liable to "rust" than the hard local variety, besides the price obtained for it is Rs 2 As 14 per maund, as against Rs 2 As 8 per maund for the Sind wheat. The Report further says—"The experiments show that the 'interchange of seed between various Provinces is most successful." In Reports of the Bengal Agricultural Department it is stated that Buxar wheat has been successfully introduced into Bhagalpur, and has produced a wheat which fetches quite 6 annas a maund more than the local grain.

2. Cotton

Mr Ozanne, the Director of the Bombay Agricultural Department has made many experiments with a view to improving the quality of cotton produced in the Presidency. American varieties of cotton have been acclimatised at Dharwar, and then transferred to Khándesh and other districts, and an endeavour is now being made to perpetuate the long-stapled varieties of Berar cotton known as *banu* and *jari*. It is found that the American varieties give a smaller yield until they have been acclimatised to a district, and hence the cultivators do not care to risk the immediate loss incurred. This militates against the spread of the growth of better varieties of cotton in India.

3. Maize and
Sugar-cane

It is very certain that, not in wheat and cotton alone, but in maize and sugar cane cultivation too, improvement may be effected by the introduction of varieties new either to a particular district or to the country.

Need of caution
in trying new
varieties

It is necessary, however, to interpose a caution against trying changes of this kind on any but an experimental scale at first. There should also be some *prima facie* indication, such as would be derived from a similarity in the climatic

conditions of the respective regions, that the transference is one likely to succeed. The unsuccessful attempts to introduce English wheats into India are instances of want of understanding of the relative conditions of English and Indian agriculture, and provincial Departments of Agriculture would do well to consider these before they accept the assurances of enterprising seed merchants in England. The season in India is too short for English wheat to mature, and, although grown in the cold season, the wheat does not (except in the hills) lie under snow, nor is it subject to severe frosts. Consequently, 20 to 30 days of heat will cause it to grow rapidly, and if the grain be not formed by February the crop will be prematurely ripened. What is wanted is not so much to try exotic or imported seed, which may be good one year and fail to produce good results the next, but to try indigenous varieties which have already been found by the experience of other districts to be well adapted.

When, however, a new variety has been found to be, beyond doubt, superior to a local one, Experimental Farms can do a most useful work in distributing the new seed, as also in selecting and perpetuating pure and good local varieties.

Use of Experimental Farms in distributing new varieties

312 It is not alone in the introduction of new varieties, but also in that of new crops, that improvement is possible. Here, again, Experimental Farms have not been backward, and though it may be asked how many of the new crops tried at these Farms have ever been fairly introduced, I maintain that such work of enquiry is a legitimate one and that it is the necessary fate of all experimental work that only one or two things out of a hundred tried may possibly succeed, nevertheless, the record and observation of what has been done will not be altogether thrown away. It will be known what has been tried, and so need not be tried again, also, what may possibly succeed under other circumstances.

Introduction of new crops

Introduction of new crops may take place in two directions. The crops may be either entirely new ones to the country, or merely new ones to the particular district.

The history of the present crops of India is one telling largely of importation, such imported crops are—the numerous millets (the principal food grains), maize, tobacco, tea (though the shrub was subsequently found and cultivated in India), coffee, the potato, and many other kinds of vegetables. There is, therefore, no reason why other crops should not be imported also. At Government Stud Farms Incense has been introduced with much success.

Where a crop is not known to one district, but is to another, improvement may often be effected by the transference of practice. There is little doubt that the cultivation of the potato might with advantage be introduced to fresh districts. At Salem (Madras) vegetables, such as the onion, the pumpkin, the egg-plant, etc., are grown in profusion, but the potato is not raised, the people say they do not know how to cultivate

it. Wheat might be grown in parts of Eastern Bengal where it is not now known. Oats might usefully find a wider sphere than they occupy at present

Extension of
cultivation of
existing crops

313 An impetus can, in some cases, be given to the extended cultivation of remunerative crops, such as sugar-cane, potato, etc. This will, however, result rather from the adoption of better modes of cultivation or of manufacture, than from other means. At Dongasara, in the Central Provinces, I found evidences in the disused stone presses still lying about, that sugar-cane was formerly grown here, but now it is not cultivated. With the help of the new iron sugar-mill the cultivation of sugar-cane might once more be profitably followed. Pointoes grow very well in Dacca, but the acreage under this crop is very small, and might readily be increased. I believe that good may be done also in increasing the variety of crops grown, and in obviating thereby the placing of so much dependence on one crop alone. Tanjore, for example, depends practically upon rice, Bellary upon cotton. If other crops were more extensively cultivated, the consequences attending the failure of the staple crop would be minimised.

Diseases of
crops and
insect attacks

314 I wish to note here the desirability of gaining more knowledge as to the diseases to which crops are liable, and of the injurious insects which attack and destroy them. It is satisfactory to note that the Government of India have, with the co-operation of the Trustees of the Indian Museum, Calcutta, made a beginning in this direction, and that the services of Mr. E. C. Cotes, of the Entomological Society, have been utilised, not only for investigating the diseases of crops, but also for investigating on plant life.

The valuable services which, in England, Miss E. A. Ormerod has rendered to agriculture may be taken as illustrative of the good that may be done similarly in India.

Out-turn of
crops

Crop experi-
ments

315 There is still much to learn in respect of the out-turn of different crops. A system of "crop experiments," or experimental trials, has been carried on in the Bombay Presidency and in a few other Settlement purposes. The trials are carried on on small accurately-measured areas being cut, and the produce weighed. The object is not only to get to know the yield of different crops, but also to find out the incidence of assessment on the value of the gross produce, and thereby to ascertain if the land-tax has been justly estimated. In a few cases further special experiments over entire holdings are made for the purpose of ascertaining whether a fair return is given for the cost of cultivation, etc. Considerable difficulty is experienced in getting these trials carried out accurately, and the returns need to be subjected to careful examination and criticism before being accepted. I regard the work, however, as a very desirable one to carry on, for, by the compilation of these returns, considerable agricultural knowledge may be gained as to the yield of crops in different parts of a Province, as well as of India generally, while, as stated, they will also be found useful for assessment purposes.

316 Improvement, both in crops and in their cultivation, may be effected by a transference of method from one country or locality to another. The introduction of new crops and of new varieties affords in itself instances of this improvement by transference of method.

Transference of method

Many of the improvements which I have summarised in paragraph 302 come under this same head, and are connected more or less nearly with cultivation. I shall, therefore, only give now some improvements which are directly concerned with actual crop-growing.

317. Rice, in its many varieties, is not sown in the same way everywhere. Sometimes it is sown broadcast, sometimes it is transplanted from seed-beds. It is known that the out-turn of transplanted rice is greater than that of broadcasted, and only the better

Improvement of rice cultivation
Sowing of rice

pointed out to me that rice is sown broadcast in the Raipur and Bilaspur districts of the Central Provinces and is not transplanted even on the best lands. Enormous waste of seed is thereby incurred. In the Sambalpur and Bhandara districts, on the contrary, rice is very extensively transplanted.

The rice cultivation of Tinnevely is far superior to that of Tanjore, and the out-turn is much better. The difference is the result of the inferior cultivation in Tanjore. Whereas in Tinnevely it is the rule to manure the land by ploughing in green crops, wild indigo, etc., this is not done in Tanjore. The practice of manuring rice land is now becoming much more frequent. At Ahmedabad I found that it was the rule to manure with cow dung, tank silt was also used. At Belgaum all rice fields are manured with cow-dung and with ashes from the villages.

Manuring of rice lands

practice to plough up the
This is done in Tinnevely
Tanjore, been struck by

Ploughing of rice lands direct after harvest

the hard and baked surface could not help thinking that the land were ploughed up the land is left to get hard and dry, evaporation is more rapid, and when rain comes it is not so readily absorbed as when the land is in a finely-tilled state. But if the field were to be ploughed after harvest it would be easy to work, the stubble would be allowed to

ld be
crop
I am
aware, but there are very many parts where it might be done quite well. At Shiyah (Tanjore) the cultivators allowed that after the

is enough moisture after the rice is off, a crop of gram and some times even of castor (*Ricinus communis*) is sown. At Belgaum almost all the rice land is used a second crop of wheat, peas, lentils, or other crops. There is no great loss of seed.

Nicholson, in speaking of Coimbatore, remarks on the advantage that would follow the ploughing of waste lands after harvest in November, thus enabling the November rains to be more utilised. From the Reports of the Bengal Agricultural Department I take the following —

'Rice has been so long cultivated that there is little to teach the *raiyats*, but those of one part can learn a great deal from those of another e.g. the
'Burdwan district
'harvest time
'in parts of the district
'disease

Waste of seed
sowing rice

Great waste of seed in sowing rice is undoubtedly often incurred. Mr Nicholson found that in Coimbatore 80 to 100 lbs of seed rice per acre were used in the transplanting process, he estimated that on the 87,000 acres of rice land in the district no less than 3,100 tons of seed, costing Rs 1,40,000, were used.

Mr. Sabanayagam Mudliar is also of opinion that far more rice is used in sowing than is necessary, and at Shiyali he adopts much thinner seeding than is usually practised around him. As instanced above, there is much waste of seed when, as in the Raipur and Bilaspur districts of the Central Provinces, rice is sown broadcast, instead of by transplantation.

Excessive water
used for rice
cultivation in
some parts

Inferior cultivation of rice is sometimes due to the fact that water is allowed to stagnate on the fields, this is the case at Dacca, and I have also seen it at Ferozepore. There is little doubt that water is frequently shamefully wasted in rice cultivation, and though plentiful water is requisite, stagnation is harmful to a crop. Mr Nicholson says — 'The difference between a paddy (rice) field and a swamp is that in the former water is not allowed to "stagnate on the surface"'. He instances that as much as 12 feet depth of water is sometimes used in a single season for rice cultivation. It might be possible to effect improvement by a transference of practice in respect of the moderate use of water.

Rab cultivation
in some parts

I mentioned in paragraph 151, when speaking of *rab* cultivation, that in some parts of Bengal, where soil is poor and weeds predominate a kind of *rab* process is used, all manure being burnt before it is put on the land. In other parts this process is not employed. In Bombay the reasons for use or non use of the *rab* process are well understood, but this is not the case in Bengal, and it is quite possible that a transference of method in this respect may be followed by benefit in parts where the system is not known.

Excessive grazing
by cattle

Burma they introduced the practice of letting their cattle graze

over the young rice, thus keeping it back. This practice was thereafter followed by the Burmese cultivators with success.

Thus, even with a c ^{is, in some parts, room}
the transference of the

318. There is much that one district can learn from another in ^{Improvement in cultivation of sugar cane}
the ^{ve method of sowing}
14 times, the plough
fine seed bed 4 or 5
be cuttings of seed-

cane are scattered broadcast over the surface. The seed is then
lightly covered over with soil. In consequence, the cane grows
irregularly, and a jungle is formed, weeding cannot be properly
done, and air and light cannot properly penetrate ^{Different systems of sowing sugar cane}

The Mauritius system is to place the cuttings in holes about 9
inches deep, placed along rows $3\frac{1}{2}$ feet to 4 feet apart, or else to lay
the cane along channels or furrows in the bottom of which the
manure is put, and the cane shove it. The "hole" system is mostly
used on undulating ground, but the "furrow" system is the best
wherever irrigation is required. Thus the "furrow" system is the
one best suited to India. If the plan of sowing the seed cane in fur-
rows were to entirely replace that of simply levelling the ground
and sowing the cane broadcast over the field, a very much increased
yield of sugar would be the result. Messrs. Thomson and Mylne
have clearly demonstrated at Bebeea that this would be the case,
and that the cane grows very much thicker if planted deeper.
Nevertheless, the Behar cultivator, even on Messrs. Thomson and
Mylne's own Estate, continues, with few exceptions, to adopt his old
plan of broadcast sowing, and non use of manure. It is noteworthy,
however, that the iron sugar-mill is now universally employed. ^{Advantage of Mauritius system}

Although in many parts, as in Bebar, the old method of sowing
the best classes
at advance, and
that is wanted is
to make the practice universal.

As a contrast to careless methods of sowing I call to mind a practical ^{Instances}
demonstration which a cultivator at Mithim gave me, of the way in which
sugar-cane is grown in the Thana district of Bombay. The entire pro-
cess was carried out on a small scale before my eyes, and I could not
but wonder at the great care displayed in every detail. The lines in
which the cane was to be sown were pegged and marked out with strings,
the seed cane was set at regular intervals, a stick being used to mark the
respective distances apart, the soil was next covered over, and water was
refuse)
be latter
wonder

Again as contrast I mention the following from Mr. Deane's Report on
the Agriculture of Palawan. "The cultivation of sugar cane is very
negligent, as now carried on, cuttings are sown at random and lightly
covered with soil, the fields are not hoed properly and light and air do
not get in. This is very different to that of the central districts of Bengal,

"where large kinds of cane, e.g. *samsera* are grown and are planted in furrows, the stems being wrapped up in leaves in the rainy season thus letting in light and air, here oil cake is used as manure and the fields are hoed. So the Palamau *raiyat* gets his 2½ maunds of unrefined sugar (*gur*) per acre, while the *raiyat* of Bardwan or Hooghly will obtain 60 maunds.

The Mauritius system of cultivating sugar cane is practised around Calcutta, but is unknown in Bhagalpur and the greater part of the Patna Division. The cultivation of sugar-cane is much better in Burdwan than in Sinhabad, though the manufacture of *gur* is, on the other hand, superior in the latter. At Hospet (Madras) sugar cane is largely grown, it is always planted in furrows, these being split after about three months. At Meerut, Saharanpur, Hoshiarpur, and generally throughout the North-West Provinces and the Punjab, the "furrow" system of planting is adopted by the better cultivators.

Improvement in
cultivation of
the potato

319 The cultivation of the Potato is carried on much better in some parts than in others. I find it stated that in Rawal Pindi—

Potato cultivation is not good and leaves much room for improvement. 'large and quick returns are obtained for a year or two and then fall off, owing to want of careful husbandry.'

In Lohardaga, potato cultivation is not carefully carried on, but in Hooghly and East Burdwan it is good.

Other instances
of transfer of
method

320 The sowing of "dry" (unirrigated) land in Northern Madras by means of a seed-drill has been mentioned, whereas this is unknown in Southern Madras (see paragraph 294).

In Tinnevely cotton is not drilled, but it is very probable that if this were done much less weeding would be requisite.

Mr Hill, Officiating Inspector General of Forests, in his Report on the Coorg Forests points out the benefit that would result from teaching the Kurubars of Coorg the plan of teak seed planting adopted by the Karens of Burma. At the commencement of the rains the seed is laid down in beds from which, as it begins to germinate, it is picked out and transferred to land on which rice, vegetables, etc., are grown. The teak seed is put in lines 9 feet apart, and 4 feet intervene between each seedling. The rice or other crop is reaped and the young teak plantation is left.

I might mention many other instances where benefit would follow the transference of cultivation methods, but the foregoing will fully suffice to make my point clear.

CONCLUSIONS.

CONCLUSIONS

321. The differences which are met with in methods of cultivation throughout India are largely those belonging to the third class of differences set out in Chapter II, *viz*, those arising directly from *want of knowledge*. The variety of crops grown is, of course, bounded to a great extent by physical conditions, such as climate, soil, water, etc., but, as has been shown, it is in some degree also due to want of knowledge. Improvement in Agriculture will, as before, result from a modification of these differences. Such modification will be effected mainly by the transference of method from one district to another, and even from one country to another. The practice of other countries, as seen in the case of the many imported crops now common in India, as also in the planting of sugar-cane, may often be usefully adopted, so also may that of the better indigenous districts.

In the work of transference of method the people are likely to do but little or nothing, and the duty once more falls upon Government, and upon Agricultural Departments in particular.

The principal improvements that can be effected are in demonstrating at Experimental Farms the benefits of selection and change of seed, in giving facilities for the supply, purchase, and distribution of good seed, in demonstrating the utility of new varieties of existing crops, in testing and introducing new crops, in investigating the diseases and attacks to which crops are subject, in transferring a better method of cultivation to a district where an inferior one prevails.

It is very clear that no work such as is contemplated in the foregoing suggestions, and more especially in the last-named, can possibly be carried out without a very thorough knowledge of existing practices. This knowledge, it seems to me, is still wanting, and can only be attained by a definite system of Agricultural Enquiry.

RECOMMENDATIONS.

RECOMMENDATIONS

322 I recommend —

The continuation of Experimental Enquiry at Government Farms in regard to selection and change of seed, growth of new varieties of crops and of crops altogether new, methods of cultivation, etc.

The Establishment of Seed Farms under Provincial Agricultural Departments for providing good seed for the various districts, and the giving of facilities and encouragement for the purchase of seed from these Farms by the cultivators.

The pursuit of the study of Diseases and injuries of crops.

The organisation of a system of Agricultural Enquiry, for the purpose of obtaining a thorough knowledge of present Agricultural methods, and for the transference of better methods to districts where inferior ones prevail.

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CHAPTER XIV

AGRICULTURAL INDUSTRIES AND EXPORTS

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AGRICULTURAL
INDUSTRIES AND
EXPORTS

323 In addition to the ordinary crops which the *raiyat* cultivates for his own use, there are some such as tea, coffee, indigo, sugar, and tobacco, which undergo a process of manufacture before becoming marketable articles, and others, such as cotton and wheat, with which special considerations in the matter of export are bound up.

In the previous chapter *cultivation* only was dealt with, and suggestions were made as to how it might be improved. I propose here to treat of points in which I think an improvement, either in *manufacture* or in the conditions of *export*, may be effected.

I said then that it was no part of my duty to describe crops or cultivation, so it is not for me here to describe manufacturing processes, or to touch upon the relations of trade between India and other countries, or upon the varying elements which affect it.

Scope of this
chapter

During my tour I had the opportunity of seeing the industries connected with the utilisation of the above named crops, and I shall briefly note any points which especially struck my attention as affording evidence of the possibility of improvement.

Sugar

Sugar

324 Sugar cane is certainly one of the most profitable crops for the *raiyat* to grow. There is always a ready market for the manufactured sugar, and, generally speaking, the area of land under sugar cane is not sufficient to meet the local demand for the unrefined sugar or *gur*, as it is termed. As a consequence of this and of the high rates for transmission within the country itself, a great deal of sugar is imported from Mauritius.

In the Bombay Presidency it is estimated that, after deducting all expenses, a profit of from Rs 30 to Rs 40 per acre may be made by sugar-cane cultivation. The general out turn of unrefined sugar (*gur*) may be put at one ton per acre.

Sugar-cane is a crop particularly well suited to India. The soil is adapted to it, and the climate is by no means unfavourable. Where irrigation is obtainable, cane can, as a rule, grow well, and yield a very rich return. India indeed, in the matter of sugar production, ought to be an exporting rather than an importing country. It is well, therefore, to look at some of the reasons which have caused the present condition of things, and to consider whether they can be removed.

325 In the last chapter I have spoken of the cultivation of sugar-cane, and have shown that there is room for improvement in it. The improvement will consist principally

Improvement in
production of
sugar

in adopting the "farrow" system of planting (*see* paragraph 318). Beyond this, there are points connected with the manufacture of sugar from the expressed juice, which have been touched on under the head of "Implements" (*see* paragraph 288). If I were asked what had tended most to render the manufacture of sugar not as satisfactory as it might be, I should be inclined to say, "The little that is really known as to what influences the yield of sugar." On these points I will briefly touch.

In improvement in
sowing

326 In the first place, although it has been shown at Beheea that cane planted according to the Mauritius plan produces more sugar than when sown broadcast, more precise knowledge is required in regard to other parts of the country also, and the demonstration of the fact should be made clear to the people

The yields from
different varieties

Next, whereas many different varieties of cane are grown, very little indeed is known as to the yield of respective varieties. In one district one kind of cane is in favour, in another a different kind. Sometimes a cane is required for eating purposes, sometimes one that will resist the attacks of white-ants, or one that jackals will not destroy. But, though each may have its special merits, next to nothing is known of the actual amount of sugar that each will produce. Mr. P. M. Gill, of Nellikuppam (Madras), in a report issued not long since, points out the great differences which exist in the juice of different varieties of cane. From his own experience he deduces the result that the variety of cane known in Trinidad as "Green Salangore" gives a better juice than any variety of cane grown in Barbadoes. This variety Mr. Gill believes to be the same as the ordinary Coimbatore cane. He therefore advocates the cultivation of this variety in preference to any other. Mr. Gill strongly urges the necessity for investigation into this branch of the sugar industry, and that careful analyses and records should be made and collected.

Influence of
weather, soil,
water, and
manure

327. The influences of weather, soil, water, and manure, in determining the yield of sugar, are but little understood. The reason is not far to seek. It is, that no one has specially worked out the question for India. Here and there a few analyses have

employed who
needed is that
is not peculiar
to one part of India alone. To give a single instance in the neighbourhood of Poona, where cane is very extensively cultivated, and

one of the reasons why the sugar factory at Poona is not successful

native cultivator has a partiality for well water in preference to canal water, if both be obtainable, and that he sets a certain store upon water of a particular kind which is highly charged with

soluble salts and which he considers especially favourable to sugar-cane and tobacco crops. The use of earth impregnated with nitre, for putting round the stems of sugar-cane as a manure, has also been referred to (*see* paragraph 133).

328 Next, there is uncertainty as to the right time for cutting the cane. This can only be definitely arrived at by careful investigation and by the aid of chemical science. It is well known, however, that the measure of success attained depends much upon the time of cutting. If the cane be cut too early, the saccharine juice will be found not to be sufficiently developed, whereas, if left too long, some sugar will be transformed into fibre and other constituents. The desideratum is to take the cutting at the time of maximum development of sugar. The chemist at the Rosa Factory in the North West Provinces has made analyses showing that the top joints of the cane contain no cane-sugar, even when nearly ripe, and that the common practice of reserving whole canes for "seed" is a wasteful one. The West Indian planter only uses the top of the cane for "seed," and this, though done in parts, ought to be done universally in India.

329 Another point on which there is very uncertain information is the extent to which the system of "ratoon" growing is a profitable one. In some parts, the cane, instead of being freshly planted each year, is allowed to stand over for a second, third, or even later season, and is then called "ratoon" cane. At Poona I saw such a crop of the sixth successive season, but the opinion is general in the district "that ratoon growing" will pay for three years, but not longer. The advantages are, that much less labour is required, and that only half the amount of manure is used. On the other hand, there are the objections that after a time the land gets sticky, and cannot be worked properly, also that the new shoots spring out from "eyes" higher up the stem than they did when the cutting of seed cane was deposited below the ground, and in this way roots grow out above the surface of the soil, giving the cane a less firm holding and less power of drawing upon the nourishment placed below it. I could not, however, obtain anything but expressions of general belief, and it will not be until the respective systems have been tried side by side, and the cultivation expenses, out-turn of sugar, and other items have been drawn up in a balance sheet, that really reliable information can be given. Such work as this would be a most useful one for Agricultural Departments to undertake, and I would urge it being done, not only on Experimental Farms but on land in the actual occupation of cultivators. Where, as on an Experimental Farm, all labour is hired, cultivation expenses are very different to those which the *rasyat* would have to meet, and therefore it is of advantage to take land under ordinary cultivation, and to see exactly what it would cost the *rasyat* to carry out one or the other of two competing systems.

330 The point at which, perhaps, the greatest waste of sugar occurs is after the cane has been cut, and it is largely in consequence of imperfect management in the stages subsequent to the cutting that India is an importer of foreign sugar.

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Time of cutting
cane

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The ratoon
system

Experiments
should be made
upon its value

330 The point at which, perhaps, the greatest waste of sugar occurs is after the cane has been cut, and it is largely in consequence of imperfect management in the stages of cutting that India is an importer of foreign sugar.

Indian cotton have been very great. The cotton most largely used in this way is the *Pilangati* or *Paradi* cotton of Khandesh. The cotton grown in Bengal, the North-West Provinces, the Punjab, Rājputāna, and Central India generally, is known as "Bengals," that from Madras and Western India generally as "Westerns."

Attempts to im-
prove cotton

339 Many efforts have been made, and even Government legislation has been tried, in order to keep pure the finer qualities of cotton, and to prevent the increased growing of the coarser native kinds. But all these efforts have failed, and at the present time the cultivation of the indigenous varieties is more extensive than ever. The reasons are, briefly, that the country cotton is a better-yielding variety, it is earlier, and more hardy than the long-stapled kinds, besides, it commands a good price, the crop pays the *rayat* well in grow, and there is a ready demand for every bale that is grown. The *rayat*, therefore (and, as it seems to me, wisely), concludes that he is justified in continuing to cultivate the coarser kinds, and he does not care to run the risk of growing a smaller-yielding

to wait longer for it, and in the for it. A quick return means, repay the loan he has obtained for the seed and the cultivation. The general opinion is that it is useless to interfere by legislation, and that unless it can be shown to the *rayat* that he will get more for growing fine cotton than he does now, and more than will cover the risk he runs, he will continue to grow the coarser as it has done before, to seed which he knows will early

demand which exists for the country cotton, and so long as merchants will not give higher prices for better kinds, the supply of country cotton will be maintained. But if the complaints made against Indian cotton proved to be so well founded that the merchants had to stop purchasing the cotton, then, I believe, the *rayat* would very quickly alter his practice and grow the finer kinds. In this matter, as in many others, the cultivator would show himself quite alive to his own interests, and he may be very well trusted to do what pays him best.

The preservation
of better
varieties

340 There may, however, be some fear that if there were a sudden demand for finer cotton the *rayat* would not have the seed for growing the crop. Therefore, I regard with favour a proposal made by Mr. Osborne, to grow and to perpetuate a certain quantity of pure seed of some of the better varieties, such as *banis* and *gari*, which are still known in Berar.

It would, further, appear very desirable to have some recognised trade mark description for the various kinds of cotton grown. At present there is no protection for any of the admittedly finer varieties, although merchants might be willing to pay a higher price for them.

The misfortune as regards the cultivator of the better kinds of cotton is, not only that there is no protection afforded to him whereby a certain name and better price would be secured for his

of the political relations of planter, *zemindar*, and *raiyat*, as well as of the past and present condition of the people in the indigo-growing districts.

These points all bear upon the indigo industry with which, I shall, as I have done, discuss the matters which came under my notice in visiting the indigo districts of Behar.

Its cultivation

344. Indigo is grown under several different systems, the merits of which I will not discuss, but, generally speaking, the *raiyat* covenants with the European planter to grow indigo for him over a certain proportion of his holding. There is no stipulation as to how the land thus set aside shall have been previously cultivated. The planter has, in addition, a certain amount of land around his factory which he cultivates principally indigo, and also sugar-cane, *guar*, &c., and some other fodder-crop for feeding cattle (see paragraph 236).

The cultivation of indigo has been very greatly improved by the European planter, and the native growers have to some extent followed the example set them. I have noted the following improvements:—the sowing is done in the rainy season, the fallow is shorter, the attention is more complete, the indigo is planted in rows, and on indigo estates or "concessions," as they are called, there is a large area to be sown, and it is all important to get this done quickly and just at the right time. Hence the indigo planter uses a drill which will sow, not one, but several rows at a time, and he uses a large number of these drills.

Continuous cropping with indigo,

345. Whenever it is possible, an indigo crop is taken on the home land, but occasionally a change in the cropping is made. This, however, can hardly be termed "rotation," it is merely a "rest" to the land from growing indigo, and is resorted to whenever the crop shows any signs of failing. During my tour, land was pointed out to me which had been under indigo for forty years, and which was still in a state of high fertility, and was being cropped closely and recently. It was shown that the power of the soil was not exhausted. The soil is not exhausted, and the

because the nitrogen is supplied from the atmosphere (see paragraph 60)

Possible explanation

The indigo plant (*Indigofera tinctoria*) belongs to the Natural Order *Leguminosæ*, and, although scientific investigation has not,

desirable or even necessary. This is termed a "rest" for the land. Similar, though more serious in result if not freely practised, is the change required with clover-cropping in England, the land being rendered "oliversick," as it is termed, if clover be too often repeated during the course of a rotation. Miss Ormerod lately writes "The Royal Agricultural Society of England, if not causative of, thence, the prevalence of a destructive eel-worm (*Aphelenchus devastatrix*), whose extermination is best effected by "starving it out," in other words, by growing in place of the clover some crop on which the *Tylenchus* will not thrive, and in not repeating clover until the pest has died out.

Insect ravages

Similarly, the indigo crop has its own particular pests, although their ravages are not so general as to prohibit the cultivation of the crop. Caterpillars and a kind of cricket called *zirrah*, which burrows in the ground, are its principal enemies.

Advantage of change of cropping

A change of cropping is the most effectual means of getting rid of the pests both insect and vegetable, which attack the plant, and which are more or less fostered by the continuance of one and the same crop upon the land. A change in cultivation is also beneficial to the soil, and the growing of a crop different in its plant requirements to the preceding one enables dormant or non-utilised constituents in the soil to be made use of to the advantage of the new crop. I believe that change of cropping might be usefully followed in indigo cultivation to a much greater extent than is now the case, and this without expenditure of more manure. What has told in the past against the practice is the anxiety of the planter to get his money as quickly as possible out of the indigo cultivation, and therefore to put as great a breadth of land in indigo as he can.

Selection and change of seed.

347. Care is shown in the selection of seed, for in this respect the European planter does not follow the Native. There are English merchants at Cawnpore and elsewhere who make it their business to select and sell good seed to the planter, and the planter in turn is very particular to get a change of seed.

Unresolved questions as to cultivation.

Thick or thin seeding
Measuring

348. There is, however, considerable uncertainty as to whether thick-seeding or thin-seeding is the better. Then, uncertainty exists as to manuring, except in the value attached to the refuse indigo plant or *seel*. The *seel* water, or water run off from the settling tanks in which the finely divided indigo deposits itself, is sometimes used on the land with a manurial object in view, but it is more often allowed to run to waste, as being worthless. Its value has yet to be demonstrated, and I could form no definite opinion on the point without chemical examination and experimental trial. There is much difference of opinion, again, as to whether *seel* should be spread on the land thickly or thinly. Each planter has his own idea of what is best, and he holds to that. Another disputed question is, when the *seel* should be put on. Some planters cart it out fresh, straight away from the steeping-vats, others prefer to let it rot and to apply it when old.

planter or other who is willing to take it up from time to time, although as to what the action of the added chemical is, there is complete ignorance.

The "beating" process.

352. When we pass on to consider the "beating" process, the want of harmony between practice and theory is more than ever apparent. The accepted ideas of each are indeed almost diametrically opposed. What is effected by "beating" the indigo-containing liquid after it has been run off from the steeping-vats is very far from being known, and until some one of high chemical attainments can work on the subject, not simply in the laboratory, but also in conjunction with the actual manufacturing process, the real solution of the question will be very distant. The entire manufacture, from the beginning to the end, is one which should be intensely scientific, and should proceed on the most definite lines, instead of which it is, as I have described it, a "rule of thumb" procedure. To take a single instance. The time at which "beating" should cease is determined by a very rough test, the object of which is to find out from the colour of the liquid whether it is nearly and completely beaten, and if not, to repeat the process, and it is not more certainly whether a quantity of indigo was being run to waste or not.

The "boiling" process.

353. After the indigo has deposited itself in the "beating-vat" and the supernatant liquid has been run off, the finely-divided indigo or "fecula" is transferred to the boiling vats. But, here again, difference of opinion exists as to whether it should be boiled once only, or twice, and also as to the temperature which it is best to employ in boiling.

The practical and the chemical views compared.

354. Dr Watt, in the able article which he has written on indigo in the "Dictionary of Economic Products," reviews fully the bearing of scientific investigation upon the manufacturing process, and emphasises the failure to apply the former to the latter. The main question, as to what "beating" effects, resolves itself into that of whether *oxidation* is produced in the beating-vat or whether the change is one of a purely *mechanical* nature.

The colouring matter contained in the indigo plant is a soluble glucoside termed *indican*, which, on maceration of the plant with water, is converted into *indigo-blue*, and this latter, on fermentation, is reduced to *indigo-white*.

The view of the practical man is that when the plant is steeped in the vat, fermentation takes place, *indigo-white* is produced, and in the "beating process" it is converted into *indigo-blue*. Consequently, several of the difficulties of facilitating fermentation are removed by the addition of substances to the steeping-liquor. The "beating" process in the vat must be continued until the liquid is nearly and completely beaten, and if not, to repeat the process, and it is not more certainly whether a quantity of indigo was being run to waste or not.

virtually a tenant of the planter, but is obliged to put a certain proportion of his holding under indigo each year for sale to the planter.

It must be acknowledged that indigo-growing under these conditions is not altogether a voluntary system on the part of the *raiya*. He does not look on the indigo crop as he does on a food crop; there is not the same inducement for him to grow a good crop, either for a full-crop or for the actual yield. The *raiya* is to give his worst land for growing indigo, whilst the planter's aim is to get the best land.

On the other hand, the planter has his own difficulties. For instance, he has a large capital invested in his manufacturing plant, while he is himself placed to a great extent in the *semindar's* hands to meet the crop under the that of purchase. *khushi* system.

The prevailing system, it is right to say, is not a creation of the English planter; he found it existing when he came, and has simply continued it.

Lastly, all alike, whether planter, *semindar*, or *raiya*, suffer from the non-existence of a proper Record of Rights, in which the areas of holdings and the rents charged should be clearly defined.

Tea.

357. I took the opportunity afforded by my travels, of seeing something of tea cultivation both in the Neilgherries and at Darjeeling.

This industry, like that of indigo, is one in which empirical rules take, to a great extent, the place of ascertained and clearly-defined truths, and both in the growing of the crop and in the manipulation of the tea, there is much still to be learnt. My visits were of too hurried a nature to enable me to do more than get a general insight into some of the questions which are waiting for solution

Unsettled points
in tea cultivation

to the
series,
in the
Dar-

Then, in respect of the soil, little is known as to its requirements. In the Neilgherries, for instance, there is good reason to believe that a deficiency of lime, if not of available potash also, has had to do with the decadence of tea cultivation there. On almost all sides there is but little known about manures, even about those which are available, such as oil cake and bones; the different oil cakes are classed together just as if they were the same and of equal value, it has not been established whether bones are useful,

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It must be acknowledged that indigo-growing under these conditions is not altogether a voluntary system on the part of the *rayat*. He does not look on the indigo crop as he does on a food crop; there is not the same inducement for him to grow a good crop for a full-crop or for a high yield. The *rayat's* aim is to get the best land for growing indigo, whilst the planter's aim is to get the best land.

On the other hand, the planter has his own difficulties. For instance, he has a large capital invested in his manufacturing plant, while he is himself placed to a great extent in the *semindar's* hands.

Chasing the plant from the *rayat* by the hundle (the *hukus* system) he might not get sufficient crop.

Thus, the planter has no control over the *rayat's* crop, and has no record of the area of his holdings.

Lately, all alike, whether planter, *semindar*, or *rayat*, suffer from the non existence of a proper Record of Rights, in which the areas of holdings and the rents charged should be clearly defined.

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Unsettled points
in tea cultivation

358. There appears to be still a good deal of ignorance as to the elevation best suited to tea cultivation. Thus, in the Neilgherries, tea is grown as high as 7,300 feet above sea level, while in the Ochterlony valley the elevation is 3,500 feet only. In the Darjeeling districts similar wide variations are found.

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It must be acknowledged that indigo growing under these conditions is not altogether a voluntary system on the part of the *rayat*. He does not look on the indigo crop as he does on a food crop, there is not the same inducement for him to grow a good crop, since he is paid one of two rates, either for a full crop or for a half-crop, and not according to the actual yield. The *rayat's* constant endeavour is, therefore, to give his worst land for growing indigo, whilst the planter's aim is to get the best land.

On the other hand, the planter has his own difficulties. For instance, he has a large capital invested in his manufacturing plant, while he is himself placed to a great extent in the *zemindar's* hands. As compared to the continuance of his lease, he has to meet the the manufacture of sufficient land for growing the crop under the requisite with tea, but the *zemindar* were he to adopt that of par importance in each case. ^{the bundle (the *khuski* eye-}

363 I may briefly say that the same question alluded to as being still in dispute as regards the cultivation of present themselves when dealing with coffee growing.

The important matters of elevation, aspect, and shade, are by no means determined, nor are they attended to as they ought to be. The nature and requirements of the soil have not been sufficiently studied, whilst there is much to be learned in regard to manures, their use and value. There are diseases and injuries to which have not yet been success

Problems in
coffee cultivation

Elevation

A suitable elevation as in the case of tea, would seem to have much to do with the successful cultivation, though along with it must be taken the consideration of rainfall. The Bartchinkhulla estate is about 3,000 feet above sea-level, and the rainfall is from 90 to 100 inches, but at Messrs Cannon's estate, where coffee of the highest repute is grown, the elevation is 4,500 feet and the rainfall is only 60 inches.

Soil

The kind of soil, or rather, its earlier history, is a point of the highest importance. If the land has previously been old forest land, thinned for the purpose of growing coffee, it is likely to do well, but if it be that which has before been under cultivation, more especially of the class known as *kumri* cultivation (in which the land is cleared by cutting down the wood, setting fire to the vegetation, and growing crops without manure of any kind) it is not nearly so valuable.

The aspect must be studied, chiefly in the matter of shade, while both the presence of shade and the kind of shade provided are most essential points. Perhaps nothing affecting the cultivation of coffee impressed me more than the importance of shade. I have been over estates where shade has been attended to, and I have noticed the healthy and natural growth of the bushes.

bring the sub-soil up, for it may be poorer in quality and the richer top-soil may thus be buried.

Soil-constitu-
ents.

As to the soil itself, judging from analyses which I have made of coffee-soils from Mysore, there appears to be clear evidence (see paragraph 63, as also Appendix B) of the want of lime in the laterite soils, also that phosphoric acid and potash (see paragraph 65 and Appendix B) are less abundant than in soils of alluvial nature in other parts of India. The frequent use of bones by coffee planters as a manure is a support to the belief in the need of phosphatic manures, and it is probable that nitrogenous manures might also be useful.

Some detailed analyses of the surface soil, and some passing comment on their richness in vegetable matter and in nitrogen resulting therefrom. This is accounted for by the fact that the land is old forest land, and it is likely that lime and mineral ingredients are what the soils require rather than more vegetable matter etc. It is, indeed, produce a rankness exclusion of berry.

surface soil is found, the reverse may be the case, and there may be decided need of organic manures. All soils cannot be treated alike, but each must be considered in its own special relations.

Application of
manures

Differences of practice occur in the manner of applying manures, some planters preferring to throw manure broadcast and to fork it in, others thinking it better to dig a trench round the bush about 1 foot or 1½ feet from the stem and to put half the manure in each with which the soil is turned. A test which is the better plan, and, indeed, it would very probably be found best to put one kind of manure in a different way. The plant for which the rootlets can best avail should be in favour of scattering manure about rather than of accumulating it in one spot or even in a circle, so long as it is not too widely scattered or

has any effect on it, whereas soluble salts, such as potash manures, may well be sown on the surface or be lightly forked in. The time of application will also differ according to the nature of the manure, bones and other materials which take long to decompose being better suited for early application, and more readily decomposable or soluble manures for a later dressing.

If coffee planters would make a few small but careful experiments for themselves they would certainly be able to obtain more

375 The decline of the Bengal silk industry is believed to be in great measure due to the spread of certain diseases among silk-worms. The worst of these is known as *pebrine*, and so serious have been its ravages that an effort was made a few years back to investigate its nature and the means of prevention. Mr. N. G. Mookerjee, of the Bengal Agricultural Department, was deputed to Europe in 1888 to study the methods of silkworm-rearing practised in Italy and France, and more especially to acquaint himself with the system introduced by M. Pasteur, of examining microscopically the moths intended for laying the eggs or "seed," as the

It must be acknowledged, however, that the work is altogether satisfactory, and the steps taken in India

successful in perpetuating silkworms which are free from disease, at least in the silk districts of Bengal. Mr Mookerjee, who has had charge of the experiments, has been able to rear silkworms free from disease in places such as Debra Dun which are far removed from the silk districts, but as soon as the seed is removed to the silk districts of Bengal *pebrine* appears and it is no longer possible to keep pure "seed."

Grain-cleaning
ing

Grain-cleaning

376. The export of wheat and oil-seeds from India has introduced important considerations as to the cleaning of grain and seeds, and on these I wish to touch.

Indian wheat has, without doubt, acquired a name for being "dirty" and of being inferior to the Canadian and American wheats put upon the English market. It is stated that a considerable amount of earth, and of seeds other than wheat, come with the grain, and that this the deliveries after their arrival. The wheat has to be washed, partly in heat being very hard), and partly so as to get rid of the earth and dirt which are invariably found along with it. A lower price consequently rules for Indian wheat, and many millers who would be willing to purchase it are kept back from doing so by reason of the expense involved in providing special appliances for cleaning the grain.

Dirty
condition of
Indian wheat

The basis of sale
of wheat

377. It has been customary to sell Indian wheat on the basis of its containing a certain amount of impurities, the exact amount varying with the place of export and the time of year when export takes place. In the case of Calcutta wheat, 5 per cent of impurities used to be allowed for ante-monsoon shipments (previous to 1st July), and 6 to 7 per cent for post-monsoon shipments (after 1st July). For Bombay wheat a somewhat lower percentage, viz., 4 to 5 per cent, was allowed, but wheat from Karachi was reckoned as being more impure than that from Calcutta or Bombay, and the ante-monsoon season also extended to 30th September.

* The causes of wheat being shipped in this impure condition were alleged to be the inferior cultivation of the Indian *rayat*, the habit he has of growing wheat, not alone, but as a "mixed" crop, and the imperfect means at his disposal for threshing out and cleaning the grain. It was argued that as the cultivator threshes with his bullocks, besides this, that the *rayat* is arising from the vent a good clean

How Indian
wheat comes to
be dirty

378. That a certain amount of foreign seeds and dirt finds its way into Indian wheat from the above causes is undeniable, but as I shall presently show, this does not account for

anything like the percentages of "dirt" which it has been the custom to fix. When first the export of wheat began to assume any considerable dimensions the purchase of shipments was conducted on the system of "mutual allowances" the buyers paying for any superiority in cleanness shown above the arranged limits and the shippers paying for any deficiency. Samples of the different cargoes were submitted, on arrival in England, to the Corn Trade Association's analysts, and the percentages of impurity were fixed thereby. But it was soon found out that, despite the statements that had been made as to the *rajah's* imperfect methods, Indian wheat generally arrived in so clean a condition that the buyers had in most cases to pay for the extra cleanness. They soon got tired of doing this, and accordingly dropped the system of mutual allowances. They resolved only to purchase upon the basis of "fair average quality" (f. a. q.), thus implying that the wheat might contain the percentage of impurity or "refraction," as it is termed allowed according to the port and time of shipment, but they refused to pay for any "refraction" limit, though they still claimed an

The result of this action soon made itself manifest. Indian wheat, which up till then had been coming over clean, now began to deteriorate, its "dirty" character giving a lower price for and other wheats. But the change in the character of Indian wheat was the direct consequence of the English buyer's action, inasmuch as the Indian shippers finding that they no longer got a penny more for wheat which they sent over clean than for that which ^{intentional adulteration} took good care not to purify. This has led to the practice of not being practised, less off the cultivator's quality" as under the place of export.

270 When the buyers first began to expect clean wheat, there had not been the difficulty of dealing with it in consequence of the dirt and impurities it contained, and the expense they were put to in removing these. Messrs. McDougall Brothers, of Mark Lane, London, specially interested themselves in this matter, and laid before Viscount Cross, the then Secretary of State for India, much valuable information upon the subject. Messrs. McDougall's enquiries elicited the facts that not only was clean Indian wheat desired, but that an extra price would be paid for it, and increased use be found for it. The desire of the millers was that admixture should be limited by contract to 2 per cent.

Reports and papers were laid before Parliament in 1888 and 1889, and on May 8, 1889, Viscount Cross presided at a Conference ^{Conference at the India Office}

held at the India Office to consider the question of Indian Wheat Impurities. In the course of his opening address his Lordship pointed out that no less than three million cwt. of dirt are imported every year with Indian wheat, and that this implies a useless and foolish expense.

The London Corn Trade Association on their part maintained that the condition of Indian wheat was a natural one, due to the methods of the *raiyat* in cultivating and threshing, and that the basis of 4 per cent. of impurity for Bombay and 5 per cent. for Calcutta wheat was accepted by shippers as being the normal condition of wheat as grown. Shipment on a 2 per cent. basis, they maintained, would imply cleaning at the place of export, and would necessitate English millers paying a proportionately higher price which they would not be found willing to do. The London Corn Trade Association raised objections to selling wheat on analysis, (in the same way that linseed is sold), and they deprecated Government interference in a trade matter which would gradually right itself and effect the desired improvement in time.

Views of
Liverpool Corn
Trade Association

The Liverpool Corn Trade Association differed entirely from the London Association, and saw no difficulty in fixing a 2 per cent. "refraction" standard, at least for Bombay wheat, they believed that if a 2 per cent. limit were fixed in England, the wheat would soon come from India of the required purity. The term fair "average quality" they felt, was a very elastic one.

Views of millers

A point of considerable importance was raised by millers in the Midlands and other inland counties of England. They pointed out the disadvantage they were at in having to pay not only for the extra dirt, etc., coming from India to London, Liverpool, or other English ports, but that they had to pay as well for its conveyance at high rates along English railways. In this way the smaller millers and those inland were much prejudiced, for they could less afford than the larger millers to put up the requisite machinery for removing the impurities which had been deliberately put in, and for which they had had to pay extra carriage.

It was not to be expected that any general agreement could

National Association of British and Irish Millers, and millers generally, strongly urged that improvement ought to be effected, that wheat should be shipped cleaner, and that wilful adulteration should be punished.

Attempts made
in India to
supply clean
wheat

General
Agricultural
Department

380. In India itself, enquiries were made, and efforts were put forward to induce a trade in clean wheat. The Reports of the Bengal Agricultural Department showed that the unsatisfactory state in which wheat was exported was not due to the inferior cultivation and dressing which it received from the *raiyat*, but that when clean wheat was offered the merchants, owing to the action of the buyers in England, positively declined to give any better price

for it than for wheat with 5 per cent. of impurities. Mr. Finncane, Director of the Bengal Agricultural Department, instances that in August 1887 the Manager of the Dumraon Raj wanted to grow wheat largely and to supply it in a clean state, if he could get a remunerative market for it. He proposed giving the *raja* advances of seed and money by way of inducing them to grow wheat alone and not as a "mixed crop;" but also to set up machinery for cleaning wheat. But he was obliged to give up the idea, for the merchants would not give a higher price, and, what was worse, the clean grain was deliberately mixed with mud so as to make it up to the 5 per cent. "refraction" before it left for shipment to England. The Manager of the Raj relates that, near Buxar, he used to sell wheat to an agent of a leading wheat-exporting firm, and that his servants were instructed how to make little pellets out of mud and water, which would resemble wheat, and to mix 2 maunds of this earth with every 100 maunds of grain whenever the wheat was found not to contain 5 per cent. of impurities.

381. The Bombay Chamber of Commerce have repeatedly urged the London and Liverpool Corn Trade Associations to accept a basis of 2 per cent. of "impurities," and have said that, were it adopted, there would be no difficulty whatever in getting any quantity of wheat cleaned to that extent. To these proposals the Liverpool Association seemed to be favourable, but the London Association declined to assent. In place of it they proposed, in November 1889, the following "refraction" limits for ante-monsoon shipments: 3 per cent. for Bombay wheat, 4 per cent. for Calcutta wheat, and 5 per cent. for Karachi wheat. Of these "total impurities" about 1½ per cent. was to "be dirt." *Somewhat higher percentages were fixed for post-monsoon shipments. The Liverpool Association joined in the recommendations. In vain the Bombay Chamber pointed out in reply that the analyses of Bombay wheat, as given by the Official Analyst of the London Corn Trade Association, showed even less impurities than the latter Association proposed, but so the matter stands.

382. I was naturally desirous of forming my independent conclusions upon the question of clean wheat, and therefore made my own enquiries. Mr. John Marshall of the Bombay Chamber of Commerce, Mr. Wishart (Cawapore), Mr. H. M. Ross (Calcutta), and others, kindly gave me much information as to the practices of the

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It was not to be expected that any general agreement could be come to at the Conference, when interests so divergent were concerned, but, although a few large millers, who had already gone to the expense of setting up special machinery for dealing with Indian wheat, were in favour of matters remaining as they were, the National Association of British and Irish Millers, and millers generally, strongly urged that improvement ought to be effected, that wheat should be shipped cleaner, and that wilful adulteration should be punished.

Attempts made
in India to
securely clean
wheat

Bengal
Agricultural
Department

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382. I was naturally desirous of forming my independent conclusions upon the question of clean wheat, and therefore made my own enquiries. Mr. John Marshall of the Bombay Chamber of Commerce, Mr. Wishart (Cawnpore), Mr. H. M. Ross (Calcutta), and others, kindly gave me rough information as to the practices of the trade; but, in addition, when pursuing my general enquiry up-country, I found that

Proposals of
Bombay Cham-
ber of Com-
merce.

Reply of
London and
Liverpool Corn
Trade
Associations

My own enqui-
ries

per cent. of "impurities" and, before being shipped to its destination, it is *made up* to the particular degree of impurity required by each country to which it is being sent. It would be quite easy, I am assured, to clean all wheat to 2 per cent. of impurity. If the English merchants really want to have clean wheat, they have only

* The term "dirt" includes earth, chaff, and miscellaneous weed seeds of no intrinsic value.

to insist upon its being supplied, and it would at once be forthcoming.

Adulteration of
wheat seen by
me

Any doubts that I may have had as to wilful adulteration of wheat being practised were set at rest by my seeing, as I was passing Changa Manga railway station (in the Punjab), a large heap of wheat being deliberately mixed with earth. This was going on in full view of everyone.

The quality of
wheat from the
cult vs. ore
threshing-floors

383. My attention was next directed to ascertaining how the impurities that are found in wheat exported to England find their way into the grain. For this purpose I endeavoured to find out what the quality of wheat is as it leaves the threshing-floor of the *rayat*, whether, in fact, it *does* contain all the dirt that it has been represented to have, for instance, the mud from the threshing floor, and the gram and other seeds from the "mixed" crops grown with the wheat.

Accordingly, when staying at Cawnpore with Mr. Holderness, Director of the Agricultural Department of the North-West Provinces and Oudh, I obtained through his Personal Assistant, Mr. Liehman Parshád, six samples of wheat which were taken, according to my detailed instructions, direct from the threshing floors of cultivators in the neighbourhood of Cawnpore, and just as the wheat was about to be sent to the nearest *barar* for sale. The wheat was accordingly in the state that it left the cultivator, and as it passed into the hands of the local traders for transmission to agents of the large wheat-exporting firms, and for subsequent despatch to the port of shipment.

The heaps of wheat as they lay on the threshing floor, ready for removal and sale, were carefully sampled by turning each over and drawing from it handfuls from different parts, turning it over again and taking fresh handfuls, and so on, until an average of the whole was obtained, which, by subsequent division and sub-division, was reduced to a lesser bulk. The final samples were sent to me and the separation of the wheat and the impurities was carried out in my presence, the results of the separation were as follows:—

Tantv VIII.

Mechanical Analyses of Samples of Wheat taken from Threshing-floors of Cultivators in the Cawnpore District.

Mechanical analyses of samples of wheat.

No	Villages	Impurities				Cawn Wheat
		(a) Crumb, and other fine stuff, with large earth.	(b) Fine by Class Immature Wheat, et c.	(c) Fine, Small Weed seeds, and Fine Earth	Total Impurities	
		Per cent	Per cent	Per cent	Per cent	Per cent
1	Einatpur .	—	—	—	15	92.85
2	Cawnpore .	35	1.19	21	1.77	95.23
3	Gotays .	20	1.34	21	1.78	95.23
4	Lukhanpur .	16	1.72	23	2.10	97.84
5	Rawatpur .	—	08	03	71	99.29
6	Aswabganj	—	1.11	12	1.23	95.77
Average of six samples . . .					1.00	98.70

NOTE.—No. 1. This sample was exceptionally clean and the impurities were too small to class by
 2. (a) mostly *Lathyrus sativus* and green; (b) barley and small wheat; (c) rape
 3. (a) *Lathyrus sativus* mostly; (b) small wheat; (c) fine earth
 4. (a) *Lathyrus sativus*; (b) barley and small wheat; (c) fine earth
 5. (a) oats; (b) wheat; (c) rape.
 6. (a) small wheat, oats, barley, earth; (c) weed-seeds. See earth.

Other details of the Analyses are given in Appendix N.

From my own inquiries, therefore, I am convinced that the wheat, as it leaves the *rayat's* threshing-floor, contains only about 1½ per cent. of anything but wheat, and that there would be no difficulty whatever in supplying clean wheat on a basis of 2 per cent "refraction," if only it were wanted.

There is another significant feature, namely, that if the earth that is so much complained of came from the threshing-floor, it would much more probably be the fine crushed earth and not the small lumps which are so generally found in imported wheat. The case of wheat is different to that of linseed, for, while the latter is generally pulled up by the roots along with their adhering earth, wheat is, as a rule, cut and not pulled.

384. The charge against the *rayat*, that he sends dirty wheat into the market is, accordingly, not substantiated. What really happens is, I believe, that the traders or middlemen between the cultivator and the exporter all have their profit to make out of the wheat as it passes down to the place of export. This they do, as I myself saw being done at Changa.

The real way in which dirt gets into Indian wheat.

Manga station, by mixing earth or foreign seeds with the wheat. The middlemen take good care that the cultivators send them the wheat clean, otherwise they would not be able to make their own profit out of it, and if the *raiyas* delivered the wheat to them dirty they would refuse to take it. But, as the grain passes on from hand to hand, each man makes his little profit by mixing other material with it, and finally it reaches the place of export, here it is made up according to the requirements of the trade with each country, and thus in the case of wheat sent to England, the 5 or 6 per cent. of impurity, necessitated primarily by the action of the London Corn Trade Association, is gradually added, shipped to England, and on its arrival has all to be taken out again.

That this is what really takes place was forced upon me still more strongly by an examination which I made of a sample of wheat taken from a bulk in Cawnpore market, exposed for sale there. This bulk I saw myself, and had a large sample of it drawn, and the impurities were sifted out and weighed in my presence. The results were —

Analysis of
wheat from
Cawnpore
market.

	Per cent.
Clean wheat	96.37
Barley . . . . .	.48
Gram, dal and other pulses	1.56
Small barley and chaff . . . . .	.44
Rape, unripe wheat, earth, etc. . . . .	.75
	<hr/> 100.00 <hr/>

3.63

This wheat was of the description known as "No. 2 Club". A noticeable difference is found between the amount of impurities in the sample from Cawnpore market and that in the samples from the cultivators' threshing-floors in the surrounding district. This tends to support the view which I have expressed, that the impurities find their way in as the wheat passes from hand to hand.

I found also that at Cawnpore the refuse from the flour mills in the town had a substantial value in the market.

The fault lies
with the home
buyer.

385 I lay the blame for the impurity of Indian wheat not upon the *raiyas*, nor yet upon the exporter, but upon the home buyer, as represented by the London Corn Trade Association in particular. The home buyer *does not want* to have pure wheat. If wheat were sold on the basis of absolute purity, this would lead to more arbitration upon samples, and would minimise speculation. If a margin of 4 or 5 per cent. of impurity is given, the buyer will look at a sample and judge very fairly whether it has 3 per cent. of admixture or more than this, but if the basis of sale were "absolute purity," or else 1 per cent. of impurity, there would constantly be arbitration as to the exact amount, and the buyer, instead of as now getting a delivery sometimes better than usual, and

The inducement to keep
up the present
size.

being able to resell it at an advantage, would have the element of speculation removed and only be able to sell on the certified quality.

The presence of admixture in Indian wheat keeps its price below that of Canadian and other wheats, and thereby offers the inducement of a lower price to buyers, and promotes speculation. So long as the term "fair average quality" is retained, the meaning to be attached to it will be a very elastic one.

Unoubtedly, too, not only are the merchants opposed to any change in the existing practice, but there are also large millers to whose interest it is to keep Indian wheat "dirty." They have put up extensive and costly machinery purposely to enable them to deal with Indian wheat, and, being able to buy the latter at the lower quotation, they secure an advantage over their smaller rivals who cannot go to the same initial outlay.

386 It has been suggested that if the "elevator" system, ^{the elevator} which is in vogue in America and in Russia, were to be introduced ^{into India} into India, the grain might be screened in bulk and be graded at the different depôts, so that it would sell according to its ascertained quality.

But there are difficulties which make the system inapplicable ^{1 applicable to} to India. Apart from the undesirability of subsidising, as has ^{India} been suggested, any private firm for a term of years to carry this scheme out, and apart from the impossibility of Government taking in hand the whole wheat trade of the country, there are considerations as to the nature and methods of cultivation which place Indian wheat on a different footing to that of other countries. In the first place, Indian wheat will not keep for any length of time, but is liable to the attacks of weevil, it is thus much better suited for bagging than for keeping and selling in bulk. Secondly, the number of different kinds of wheat grown is so large, and the individual areas over which they are distributed are so small that to grade these numerous small lots would be a difficult if not impracticable task. In America and in Russia for instance, we should find one ^{kind in one} ^{country,} but in India the ^{field,} another in ^{wheat there}. Altogether, some thirty different descriptions of wheat are sent from India to Europe.

387. The real remedy for the condition of Indian wheat will be found in the abolition of fixed rates of "refraction." ^{The remedy is also the fixed rates of refraction} As long as these are maintained the exporters will *work up* to them (but if the English buyers say that they must have clean wheat it will be speedily forthcoming). France and Italy have both refused to receive dirty wheat from India, and the consequence is that they have it sent to them clean. Russian barley is sold on a basis of 3 per cent of impurity, and this plan works quite smoothly. When clean linseed was insisted upon by Calcutta merchants the *raiyats* up country soon began to screen it and to deliver it clean. At one time the same difficulties that exist with wheat occurred also with rice, but these have been now removed, and rice is sold on a "pure" basis.

The same might be readily done with wheat if the trade really wanted to have it clean.

Legislation may
be necessary

If, however, the trade are not willing to set the practice right themselves, there only remains the enforcement of legislation to oblige the sale of wheat on a "pure" basis, and to make it a penal offence to adulterate wheat, or to export or trade in adulterated wheat.

The trade, and in particular the London Cord Trade, have the power of remedying this themselves, but they have shown little disposition to do it, and it is, I think, time that stronger measures should be taken to oblige them to put the Indian wheat trade upon an honest basis.

List of

Linseed.

388. My inquiries on the matter of grain-cleaning extended to linseed as well as to wheat.

A large number of samples were collected for me in the Central Provinces by Mr. T. C. Wilson, then Settlement Officer at Damoh, and by others of Mr. J. B. Fuller's (Commissioner of Settlements and Agriculture, Central Provinces) staff. Most of these samples were taken direct from the cultivators' stores or threshing-floors, and in the manner described before. The samples were brought by me to England, and the mechanical analyses were performed in my own laboratory. In Appendix O I give the detailed results of analyses of 39 samples collected from different districts.

Mechanical
analyses of
samples from
cultivators
stores and
threshing-floors.

The seed was first passed through a coarse sieve which retained all coarse earth and large seeds, then through a finer sieve which retained the linseed, allowing the fine earth and small seeds to pass through. The amount of "sieved linseed" was thus obtained. Finally, the sieved linseed was hand-picked, and everything was removed that was not "pure linseed." The following table gives the summary of the results —

TABLE XIV.

Mechanical Analyses of Samples of Linseed taken from Cultivators' Stores and Threshing-floors in the Central Provinces.

	Pure Linseed (hand picked).	Total Impurities.
	Per cent.	Per cent.
18 samples from Bilaspur district	92.8	7.13
4 " " Paipur "	93.24	6.06
2 " " Jabulpore "	95.81	4.19
2 " " Damoh "	91.60	8.40
11 " " Nagpur "	95.70	4.21
Average from all districts	91	6

Further details of the analyses are given in Appendix O.

To one sample in particular (No 31 in Appendix O) I would refer. This is one from the Nagpur district, and was taken at Messrs. Balli Brothers' store, or "godown," from linseed which had been brought in in carts for sale at the "godown."

It gave—

	Per cent.	Per cent
Coarse earth and large seeds	63	
Fine earth and small seeds	118	
Stalks, chaff, etc., removed by hand picking	85	
	<u>266</u>	
Total impurities		2 66
Pure linseed		<u>97 34</u>
		<u>100 00</u>

The different samples give varying amounts of impurities, but, on comparing the results with those obtained in the case of wheat, it will be noticed that the average amount of impurity is higher when linseed is the crop. This is not to be expected, inasmuch as the linseed is generally gathered by pulling up the plant bodily with the roots and adhering soil, also the foreign seeds, short stalks, and chaff, are much harder to separate from linseed than they are from wheat. Yet it would appear from the results given above that when the merchants want well-cleaned seed, they can get it readily enough.

389. I ascertained at Bombay that the usual plan followed in buying linseed for export is as follows—The seed is bought from the up-country *raiyats* by the dealers, the latter bring it to Bombay or some other port and place it in the *bardar*. An intermediary called the *muccadam* buys the seed in the *bardar* and cleans it, he brings samples to the various seed-shipping firms, and covenants with them to supply a certain amount like the sample, of a definite percentage of purity and at a certain fixed price. The linseed is generally bought in India on a basis of 94 per cent. purity, and is sold to buyers in London and elsewhere on a basis of 96 per cent. The *muccadam* is responsible for the purity, and if, on arrival in England, the seed is found, according to the test of the Oilseed Association, to come out below guarantee, an allowance is made for it, and the *muccadam* has to pay this to the shipper. But if the English buyer gets a seed of higher purity, he is not called on to pay for anything above the guarantee. Accordingly, the shipper's *chance* the deduction being made for anything below the guarantee, and take care not to send any seed of above 96 per cent purity. Formerly, linseed was bought on the "reciprocal basis," the purchaser paying more for the *cleaner* seed, and being allowed for that which was less clean. This clause, however, was eliminated by the home buyers, and at once the quality of linseed deteriorated, as it was no longer in the interest of the exporter in India to get pure seed.

Method of purchase and export of linseed

This is, however, a matter, not for Government, but for those engaged in the indigo trade

The quality of Indian cotton is no doubt inferior to what it used to be, but the cause is the demand for cheapness, and the remedy is not with the *raiyat*, nor with the Government, but with the trade. It is advisable that seed of the better varieties of cotton should be preserved in case of a demand arising for them in the future, also, it would be very desirable to secure by recognised trade-marks the various kinds of cotton which are grown, Government can, however, do but little else

In the cultivation and manufacture of tea, there are many points which call for the aid of the chemist. This has been already recognised by the Indian Tea Association. The same applies in some degree to the cultivation of coffee, and still more so to the curing of tobacco. The employment, however, of the necessary scientific assistance is a matter for those engaged in the particular industries rather than for Government.

The fact that the Indian wheat imported into England has the name of being "dirty," arises, not from bad cultivation or from carelessness on the part of the *raiyat*, but from the action of the English Corn Trade. Clean wheat is not desired by English buyers, and exporters consequently make up their cargoes to the requirements. Wilful adulteration of grain consequently takes place in India. If clean wheat were wanted it would be at once forthcoming. The elevator system is not applicable in the case of India. The remedy for "dirty" wheat will be found in the abolition of fixed rates of "refraction," but, unless the trade itself adopts the remedy, it will be necessary to make adulteration of wheat a penal offence, as also the export of, and trading in, adulterated wheat.

RECOMMENDATIONS

RECOMMENDATIONS.

391. I recommend —

The setting on foot of Enquiry by Agricultural Departments in order to ascertain the best methods of cultivation and manufacture of crops, such as sugar cane, indigo, tea, coffee, tobacco, etc., and the endeavour, by demonstrating these methods, to extend the cultivation and increase the out-turn

The employment of chemical science in the investigation of problems affecting these industries, and more particularly that of an Agricultural Chemist in connection with the sugar industry.

The making it a penal offence to Adulterate wheat, or to export, or trade in adulterated wheat.

392. In my opening sketch (Chapter II) of the grounds upon which I considered that improvement in agriculture was possible, I mentioned the existence of differences in agricultural practice which could not be traced either to physical conditions or to want of knowledge, but which resulted from varying economical and political conditions. As an instance, I mentioned the effect which pressure of population, or the absence of that pressure, would produce upon the agriculture of any part, and I indicated that a modification of the differences which exist might be accompanied by a change in the agricultural practice. Thus, if in one part the conditions of living are easy, the agriculture will often be found to be lax, whereas when the struggle for existence is harder, the agricultural methods will frequently be more closely attended to. Another element which will affect agriculture is the extension of railways and other means of communication, resulting in the development of an export trade. Other influencing circumstances are the varying systems of land tenure, the relations of tenant to landlord and of people to the State, the indebtedness of cultivators, the want of capital in agriculture, and the subdivision of land.

393. These and many others are matters which exercise an important bearing upon the way in which agriculture is pursued, and if I do not do more than touch upon them, it is not because I am not aware of their importance, but because I do not feel myself qualified to treat of them. They involve questions of economy, and an acquaintance with political conditions, the consideration of which belongs to a different sphere than that of the agricultural element. Besides this, I feel that a thorough knowledge of the people, the languages and the political relations are requisite before one can venture to speak to any good purpose upon these intricate points.

It may be said perhaps, that if, whilst I acknowledge the importance of such considerations as the foregoing, I do not treat of them, of what use, then, are my suggestions? To this I reply that, even were the Government demand for land revenue remitted by one-half, it would not result in the production of that which Indian agriculture requires most of all, viz., more manure to put on the land. While this need remains unsupplied the actual produce of the soil cannot be increased, however low the rate payable by the cultivator may be. Nor can a better system of land tenure directly produce an increased yield of a single bushel per acre, nor can it provide wood to replace cow-dung, and so set free the latter for its right use upon the land. Improvement in tenure, remission of

rent, etc., may make the condition of the cultivating classes better, but they will not provide more manure, better cattle, more pasture or better seed.

394 The smallness of the holdings occupied by cultivators constitutes a limit to the possibility of improvement. The average size of a holding is probably below five acres, and each man's first concern is to provide food grains for himself and his family. Consequently it often happens that land which might grow highly remunerative crops is given up to the growing of grain crops, and the best use of it is accordingly not made. Small holdings and small capital.

Mr. Nicholson says of Coimbatore—

"The land is often landed over to poor tenants who cannot wait for rich crops like sugar-cane and plantains, but must grow food grains. Sugar-cane and plantains worth 150 rupees per acre, would grow splendidly on tens of thousands of acres of wet land, but, instead of this 20 rupees are spent to grow a crop worth 40 rupees."

The smallness of the area also limits the obtaining of the laying out of capital, as well as the benefits of superior implements, and the employment of better labour. Mr. Nicholson said that "what is wanted is not

"more farms, but more capital put not as if we were dealing with farmers occupying some two or three hundred acres each, and where capital, education, and enterprise are present, but it is the absence of these, and the subdivision of the land into small patches, that make the problem of improvement so hard a one."

395 The conditions under which land is held in the different Provinces of India have important bearings upon the agriculture. Systems of land tenure
Under the *raiyatwari* system of Madras, for example, the State is proprietor, and the latter, so long as the assessment has been fixed, is able to do with the land as he likes. However, as Mr. Nicholson points out, he gets a tendency to rent out the land to others, and to live upon the proceeds. Land may thus become the object of competition, and rich merchants frequently buy it as an investment, handing it over for cultivation by poor tenants who are themselves unable to put any capital whatever into it. There may, in this way, be an undue extension of cultivation, the *raiyat* (here really a proprietor) being allowed to take up any quantity of land, regardless of whether he can do justice to it or not. A proprietor (*raiyat*), so long as he pays his fixed assessment, is able to rent his land to sub tenants at any figure which he can obtain, and the sub tenants become really tenants at will, liable to be turned out by a higher bidder. There is, consequently, a disinclination on the part of the sub tenant to put money into the land, as, for example by sinking a well, whereas, to the proprietor there is the inducement to get the profits of a petty landlord rather than those of the hard working cultivator.

On the other hand, a great deal of land is cultivated on the *metayer* or sharing system, the tenant paying for the cultivation

and taking one-third or one-fourth of the produce and all the straw, and handing the remain or even to the landlord, the latter paying the Government assessment. The interests of tenant and proprietor thus become one.

Other systems prevail in other parts, each with its special advantages or disadvantages, but into these I must not enter, nor yet into the vexed matter of the influence of a permanent settlement as opposed to that of a re-arrangement at intervals of 20 or 30 years.

Interference of
cultivators
and
landlords.

396. The natural indolence of the cultivating class, and their recklessness in the matter of marriage expenditure and in Lagaria, are factors which affect most seriously the possibility of improving the agriculture. But here, again, I am on ground where I can make no useful survey, and on subjects which have been long enough and too amply discussed over covering the entire attention of Government. By the introduction of the *ryotwari* system of agriculture, and by laws for the purchase of land, etc., in time of scarcity, the State has endeavored to afford advantages to cultivators. But the latter have not as yet fully availed themselves of these advantages, the cause, however, in most cases, being that they are too deeply in the hands of the *haves* or money-lenders to offer any serious resistance. The *haves* are also the grain merchant, and it is he to whom the cultivator must go to the seed which he needs before his crop can be sown. The *haves* advance the seed, generally at exorbitant rates of interest, 25 per cent for six months being quite an ordinary rate. But the cultivator must have the seed, and, having kept it over for himself, he must go to the grain merchant and there a *haves* is often encountered even before it is grown. The sums spent by cultivators on marriage and dowry are enormous when compared with their incomes, and for them, as well as for what they require in the way of the various expenses to the money-lender. So long as there is any chance on which security can be given, be it crops or be it land, the *haves* are willing to advance, and when none in the hands of the cultivator is seen that the borrower must not avail. The advances thus secured are rarely repaid, and increase with an alarming rapidity interest being added to principal and forming the new principal. On interviewing cultivators in villages in the Central Provinces, I frequently found that there was not one who was not in debt to some extent or other, and yet this was not because of the poverty of the soil or the inferiority of the crops. It was a habit, and one carried to such an extent, that even those who were well-to-do to purchase their seed went, notwithstanding to the *haves*, in order to keep up friendly relations with him. In one case I found that an original debt of Rs. 100 had in a few years increased to one of Rs. 500, a *haves* had been obtaining against the borrower, but there was not the least intention of enforcing it, and it was also clear that the same creditor had already spent Rs. 500

Interference of
landlords.

Interference of
landlords.

Interference of
landlords.

in weddings, and was now about to spend another Rs. 50 in order to marry off his son.

Near Cawnpore I came to a village owned by four *zemindars*, holding 2,600 *bighas* (*bigha* = $\frac{1}{4}$ acre) between them. All four were more or less in debt. One owed Rs. 5,000 and had mortgaged his land, paying 10 annas for Rs. 100 per month; a second had had several lawsuits, and had given the *bania* a mortgage, the principal and interest to be repaid in ten years; a third had found an existing debt on the property when he came into it; and the fourth was Rs. 16,000 in debt. It was clearly impossible for these men to do anything to improve their tenants' position. The *zemindars* often are too encumbered to lay out money for well digging or for water supply by tanks. In parts of Chota Nagpur and the Central Provinces the forests have been cleared in consequence of the indebtedness of the landed proprietors, and in order to provide the latter with ready cash. In these ways the land passes from its hereditary possessors and falls into the hands of the money-lenders. In Thina (Bombay) almost all the land has become the property of non-cultivators. In the Hoshiarpur (Punjab) Settlement Report it is stated that—

Indebtedness
increases its
importance.

"owing to the pressure of population and the special tendency to litigation, and to spending large sums on marriages, the district is loaded with a large burden of debt. The area mortgaged in the last 30 years has been 116,000 acres, and that sold, 31,000 acres, or 16 per cent and 4 per cent respectively of the cultivated area. Still the mass of the rural population is better off than in most of the districts of the Punjab"

In the Central Provinces the amount of indebtedness is deplorable, and here it is the "absolute occupancy tenant" who suffers most, as he possesses the most rights, and they favour credit being given. The cultivators are, as a rule, comfortably off, and their being in debt is mostly the result of their ability to give security. To have a large sum in the *bania's* book is, indeed, considered a sign of prosperity, and the possession of good credit. The existence of the *bania* is the result, and not the cause, of the indebtedness of the *raiyat*, and amongst the surest signs of real poverty are the paucity of *banias* and the absence of jewellery on the females. The habit of getting into debt is strengthened by the almost total absence among the cultivators of any system of keeping accounts of income and expenditure.

397. The remedy for indebtedness is not the extermination of the *bania*, even were that possible, but it will be found in an increased general prosperity, which will make the people more self-reliant and independent. Mr. B. H. Elliot, of Munjerabad, Mysore, told me that formerly the cultivators around his estate used constantly to come to him to borrow money, to pay the Government tax (he lending it to them without interest), and that their indebtedness to the Government was the only debt they had. Now, however, their own patches of land have increased, and the cultivators had,

Remedies for
indebtedness

to a great extent, become free of the *baniya*, and now rarely came even to him (Mr. Elliot) to borrow money.

Mutual benefit
society at
Hospet.

In a few cases the people have combined for mutual protection against the exorbitant charges of the money lenders. In Hospet (Madras) a Mutual Benefit Society has been established in consequence of the money-lenders charging as much as 24 and 30 per cent interest. The founding of the society has brought the charges of the *baniyas* down very considerably.

Messrs Thomson
and Mylne's
action at
Beheea.

At Beheea Messrs Thomson and Mylne practically got rid of the native *baniya* by giving loans themselves to their tenants at a much reduced rate of interest. They pointed out to me, however, the absolute necessity that there was of being on the spot, and of knowing all the circumstances of the individuals who applied for loans.

Measures to
curtail money
lenders' action.

In some instances it may be necessary to adopt stringent measures against the action of the money-lenders. It would certainly seem right, after what has been said, that enquiries should be made not only into existing debts but also into the history of these debts. Mr. J. B. Fuller told me that, according to an old Hindu law, no greater arrears of interest could be recovered at any time than amounted to the principal sum, and he thought that this rule might well be revived. Mr. Fuller was also in favour of Government action in some parts of the Central Provinces. Mr. Fuller was undoubtedly present, to enable the *baniyas*. Their past experience of the extortion of the money-lenders had been so bitter that they would, Mr. Fuller thought, avoid its recurrence in the future if they could once be set free from it.

In the Sangor district of the Central Provinces the land belongs almost entirely to money lenders, and, in consequence of the way in which the *raiyats* were ground down, the plan was devised of alleviating them by giving a lower assessment to the proprietors, provided that they undertook in turn to charge less to their tenants. This plan Government approved.

But the same remedy will not apply in one Province that does in another, and each will have to be dealt with according to its particular circumstances.

Want of enter-
prise.

398 Next to indebtedness and extravagance comes, as a drawback to agricultural progress, the want of enterprise sometimes met with among cultivators. Mr. Nicholson says of Coimbatore —

"There is a low level of social comfort, and the desire for progress is prevented thereby, there is a disinclination to economy in time and land, or to exertion in unusual times and seasons. The tendency is to rent out the land, and to live on the proceeds."

Of Anantapur Mr. Nicholson writes:—

"The total absence of effort and determined struggle, except on the old lines on the part of the people, is the cause of poverty."

This lack of enterprise is not always the result of the hardship of circumstances or the poverty of the soil. Frequently it may

be the precise reverse. The Central Provinces have been described as a country of "rude plenty." The soil naturally produces enough to make the people comfortable, and for more than this they do not care. I have described in an earlier chapter (Chapter III, paragraph 23) how improvement in circumstances might be produced were the cultivators in the wheat-growing districts to raise other crops than wheat. But they get all that they want, and their wheat gives them only about two months' or three months' work, at the most, whereas, if they grew other crops, they would have to work more, and also to irrigate the land. They are ready to admit that embanking of land (*bunding*) does good, but they will not go to the trouble and expense of doing it until positively obliged. As compared with the North West Provinces, the density of population is 400 or 500 only to the square mile of cultivated land, as against 1,090, but the produce of wheat per acre is less than in the North West. Were enterprise present the wheat produce in the Central Provinces might be much more than it is. Assessment, too, is low as compared with the North West, but a low rate of assessment is by no means synonymous with prosperous agriculture. Of many parts of the Central Provinces it might be said that, were the assessment higher, the agriculturists would improve, in order to enable the increase to be met. Around Damoh the people have been obliged to embank their land so as to make the crops pay. It is certain that there are many parts where an increased difficulty of living would bring about improved circumstances, but where population is least dense but more frequently in the most fertile districts, around Benares, Azamgarh and Allahabad. In the Central Provinces the struggle for existence is the inducement to put forth effort to meet its demands, whereas comparative ease in circumstances, a light assessment and a naturally fertile soil, may prevent the exercise of energy, and may foster a backward condition of agriculture. Where such is the case no improvement can only be expected to come from the disturbance which time or pressure of population will make in the easy circumstances which exist.

Natural advantages and easy circumstances not conducive to action or improvement.

399 Attention has of late been turned greatly to the subject of the export trade in wheat, and it has been debated whether, in order to meet the distress caused by famine, the export of grain from India should not be restricted or stopped altogether. This question has been so fully and ably discussed by such authorities as Mr J. E. O'Connor, Sir Edward Buck, and Mr Holderness, that there is no call for me to say more than to emphasise the general conclusion come to that what is exported is practically the *overplus*, often specially grown for the purpose of export, and that if it did

Export of grain

then pay better to keep

The amount of wheat exported is at present only about one

per cent. of the total of the food grains produced, and only one-tenth of the total wheat crop.

Railways have, it is true, greatly facilitated export, but they have also done service in preventing fluctuation of prices in different parts, whilst their value, in time of famine, for conveying food to distressed districts can hardly be over-estimated.

CONCLUSIONS

CONCLUSIONS

400 In this chapter I have touched on some few of those economical and political conditions which have an important bearing upon agriculture and on the possibility of its improvement. Many others there are, such as social habits, emigration, etc., but my purpose has been merely to introduce a few, lest I should be thought guilty of ignoring their influence on the progress of agriculture. I have, however, expressed my inability to discuss them properly, and, besides, they are such as do not strictly fall within the scope of my more special enquiry.

I therefore refrain from making any recommendations under this chapter.

CHAPTER
XVI

CHAPTER XVI.

PRACTICAL
AGRICULTURAL
ENQUIRY

PRACTICAL AGRICULTURAL ENQUIRY.

401 The foregoing chapters consist of a review of the agricultural conditions of India, as they presented themselves to me during my tour. As each subject has been successively dealt with, I have indicated where improvement may, in my opinion, be effected.

In the concluding chapters of my Report it will be my object to discuss in detail the agency by which the suggested improvements may be carried out.

Scope of the present chapter

I have had occasion, in almost every one of the sections, to point out the necessity which exists for a systematic enquiry into present agricultural practices, and to insist upon the acquirement of definite knowledge before attempts are made to teach any fresh system, or to carry out any extended work of experimental research.

It is with this matter of practical enquiry into agricultural conditions and methods that I shall occupy myself in the present chapter.

Necessity of combining practice and science

402 Practical enquiry, or, as I may here put it, the obtaining of knowledge respecting agricultural practice, precedes both scientific enquiry and experiment. The scientist, without some know-

Knowledge of what is done elsewhere, or of what is within the reach of the cultivator, may waste both time and money in trying what has no chance of ever becoming of any practical value.

The practical
what is being done
under which it

explain the rationale of the practice, and may apply these principles to the extension of the better systems, and to the discovery of further resources, finally, by the happy combination of science and practice, the work of experiment may proceed in a definite and useful direction. In this way some advance in agriculture may be made.

The scope of enquiry

enquiry into native agriculture, and from the extension of the better indigenous methods to parts where they are not known or employed.

In addition to the improvement of agricultural methods, there comes another most important branch wherein enquiry is absolutely necessary; this is the ascertaining of the requirements of different parts of the country in respect of facilities present in some, and deficient or absent in others. To this class belong those physical surroundings which I have summarised in paragraph 18 (Chapter II), and which are comprised, mainly, in the supply of water, manure, wood, and grazing.

404. It must be clear to every one that, before any improvement The necessity of enquiry recognised
 , the first preliminary
 conditions and its needs,
 of contradiction, that,
 as regards India, comparatively little is known of its agricultural methods, and that they have only been, so far, the subject of casual and isolated enquiry by individuals. An organised system of enquiry, on the other hand, might result in the collation of definite knowledge of the agricultural resources and needs of the country.

The Famine Commission recognised the necessity of careful and organised enquiry in order to get a real knowledge of the agricultural state and conditions of India. I repeat the quotations from their Report, already given in paragraph 15 — By the Famine Commissioners

"The defect in the efforts made by Government to instruct the cultivator has consisted in the failure to recognise the fact that, in order to improve Indian agriculture, it is necessary to be thoroughly acquainted with it"

This view was also entertained by the Government of India in their Resolution of December 1891, in which they strongly urged By the Government of India
 ""
 ""
 ""

"alike for its protection against famine and for the improvement of the agricultural system."

The Lieutenant-Governor of the Punjab (Sir J. B. Lyall), in a recent note says — Sir J. B. Lyall's opinion

"I am altogether averse to attempts to give instruction in the practical business of agriculture . . . our positive and comparative knowledge of the subject are alike insufficient to warrant such an attempt at the present time"

In a Note prepared for the Agricultural Conference at Simla in October 1890, Mr. J. B. Fuller writes — Mr J. B. Fuller's opinion

" agriculture at our
 fore we can trace
 some parts of India,

The Note of the Madras Government presented to the same Conference says, in reference to the failure of experimental work in that Presidency:— Opinion of the Madras Government

"The experiments . . . were doomed to failure, either from want of intrinsic suitability or from want of knowledge of indigenous practices and conditions . . . the faults . . . would not have occurred had there been a

"department of wide knowledge and full experience of native and, especially, local practice and conditions"

The policy proposed by the Madras Government contains as its first recommendation, "the institution of a careful and definite system of enquiry into existing practices," and it mentions "the importance of enquiry as an essential preliminary to any original endeavours to improve Indian agriculture"

* Agricultural enquiry has been confined to the collection of statistics

405 The "agricultural analysis" proposed by the Government of India has, up to the present time, been confined to the collection of Land Revenue statistics, and of information regarding the liability of districts to famine, and there has been no enquiry into agricultural methods with a view to agricultural improvement. The cause of this has been the absence of any organisation for the purpose, and the want of money for instituting it. Accordingly, whilst "Land Records" have been put on a satisfactory basis, agricultural knowledge and improvement have remained much where they were when the Famine Commission issued their recommendations

This was not the intention of the Government of India

That it was not the intention of the Government of India to confine an "agricultural analysis" to the collection of statistics is shown by the following extracts from their Resolution of December 1891 —

"It is necessary to point out that the agricultural enquiry should not be confined to the mere collection or collation of statistics in the ordinary acceptation of the term. An examination of the portion of the Famine Commissioners' Report which deals with agricultural enquiry will show that, in

"this definition of a most important aim of agricultural enquiry"

Again —

"It will follow the gradual the an ord ent

Sir Edward Buck, in reviewing, in March 1890, the position of the Department of Land Records and Agriculture, says —

"The agricultural conditions have only been studied with the view of getting general knowledge as to the liability of famine, but not as regards agricultural practice its advantages and the desirability of extension, its deficiencies and possible remedies.

The need for enquiry

406. The above extracts show abundantly that the need of requiring knowledge of agricultural practice is fully recognised as a preliminary to any scheme of agricultural improvement

Before considering what agency is best able to deal with the work of enquiry, it will be well to set out in more detail some special points on which that agency might usefully occupy itself.

in addition to the general one of becoming acquainted with the systems of agriculture practised in different parts.

Firstly, it is important to ascertain the requirements of each district in regard to the provision of water, of manure, of wood,

vided; whether the *taccara* system of advances for agricultural improvement is properly brought before the people and utilised by them; and so on.

Secondly, it is desirable to ascertain where a transference of the practice of one part may be beneficially made to another part.

For instance, the planting of sugar-cane in deep and shallow evaporating-ponds, and the growing of sugar-cane, potatoes, and other crops

Thirdly, there are a number of questions of a practical nature which admit solution, and which, though mainly of the nature of experiment, cannot proceed without first employing practical enquiry. Such questions are What is the return of different crops? What is the right amount of seed to use in sowing rice? What quantity of water should be employed in rice cultivation? Does manuring of rice fields pay? Would draining of rice fields be advantageous? What is the relative outturn of sugar from different varieties of cane? Does continuous growing of sugar-cane pay? Will it pay in the long run to grow a long-stapled variety of cotton rather than the short-stapled varieties generally grown? Is interculture of other crops with cotton profitable? Is the use of bones advantageous?

Lastly, there are points more connected with the introduction

better conservation of cattle manure, the reclamation of salty land (*usar*), of ravine and other waste land.

407. The enumeration of the subjects set out in the last paragraph clearly points to the necessity of having an agency of an expert nature to deal with them. They are not matters which

The need of an expert agency

recognised since by the Landre Commissioners, the Government of India, and by individuals qualified to speak on the point.

is conveniently but erroneously called), it must be at once said that, with rare exceptions, he has not the necessary technical knowledge to fit him for the work of agricultural improvement. The early training of the future Civil Servant is not one which directs his attention specially to or encourages the pursuit of Natural Science, but it is rather one:

After the selection
inducement given to them to study natural science. It is only within the last few years that it has been introduced into the curriculum along with other branches.

whose bent is towards those sciences, a knowledge of which would be useful to him later as an Agricultural Director, is at a disadvantage compared with the classic or mathematician. I am well aware of the difficulties which stand in the way of allowing probationers to study agriculture as a special subject before going out to India, and I do not advocate that this should be done, for there are other more important duties for which the Civil Servant has to undergo a special preparation at home. But I mention these matters for the purpose of pointing out the position in India. there is a Director from

without having acquired any technical knowledge whatever of agriculture. Not even after arrival in India is the case much better, for all alike pass through much the same course of district work. In this way a man acquires a certain amount of acquaintance with the agriculture of the part where he is placed, but it is mainly with the work of the court-house (*cutcherry*) that his time is occupied. Later on, administrative and magisterial duties have the first claim upon a Revenue officer, and, unless it should fall to his lot to be entrusted with the Settlement of a district, he hardly comes at all into close relations with the agricultural practices and conditions of the part where he happens to be. An acquaintance with agriculture is, as a matter of fact, no necessary qualification for the appointment of Director of Agriculture, nor would a man hesitate, on the ground of his not having any special knowledge of agricultural matters, to accept such a post, were it offered to him. So it comes about, and the past history of Agricultural Departments abundantly shows it, that the Directors are simply men of administrative ability, taken out of the regular Revenue line, for one reason or another, but not of necessity because they have shown special aptitude for Natural Science.

At the time of their appointment, they are brought face to face with subjects which require technical knowledge for the discharge of these duties, and this knowledge leads to the neglect of the duties of the office.

The administrative duties of the office are numerous and varied; there are Land Records to be kept up, and the work of inspection of village accountants (*patwaris*) to be done, so that, with these and the necessary office work, the Director has but little time to

give to the study of the details and systems of agricultural practice, or to the possible improvement of agriculture which may arise from that study. Some Directors of Agriculture, indeed, have openly avowed their intention to confine themselves to the work of Land Records and *not to attempt* the larger one of agricultural improvement. Thus, in effect, the Director becomes what he is strictly defined as being, *i.e.*, Director of the Department, rather than what the holder of such an office should be, *i.e.*, the Director, or, better still, the Commissioner of Agriculture. The agriculture of the country can hardly be said to be capable of being *directed*, but the oversight of it in a Province may be *committed* to the care of an individual.

From having, therefore, his time fully occupied with administrative duties and with other work, but mainly from not having the technical knowledge which may fit him to deal with agricultural questions, the Director of the Department is, in most cases, obliged to leave the work of agricultural improvement alone. It is significant to note that in January 1878, subsequent to the appointing of a Director of Agriculture and Commerce in the North-West Provinces, application was made to the Secretary of State for an Assistant to the Director, on the ground that "the discharge of the duty devolving on the Director requires the possession of qualifications which cannot be acquired without special training."

It would not be right, however, were I to pass without acknowledgment the good work that has been done by some few members of the Covenanted Service who have held the position of Director of the Agricultural Department of their respective Provinces. But, when I come to examine the individual cases to which I refer, I find that in every instance the success has been the outcome of an innate love for Natural Science, and more especially for those branches of it which are most closely allied to agriculture, or from their having already possessed some practical acquaintance with agriculture. Unless one or the other of these elements be present, I fear that success will seldom follow even well intentioned efforts.

A further hindrance to progress is met with in the frequent changes which take place in the occupancy of the Directorship. A Director so soon as he has got his staff into working order, and possibly has entered upon some line of enquiry, or commenced some protective measure against famine, than he is liable to be called away to fill some higher post, while his successor may have no sympathy with his efforts, and may allow them to lapse. In this way the work of Agricultural Departments has largely been the result of spontaneous efforts of individuals rather than of one continuous system of enquiry maintained throughout. Continuous enquiry cannot be carried on without a *regular agency* for the purpose, and so long as it is entrusted to men whose tenure of office has no element of permanency about it, the results will be disappointing. I might mention the reclamation experiments at Awa and at Jhansi (*see* paragraphs 70 and 75), as instances of enquiry begun but not concluded, in consequence of changes of the

and other similar work.

**Agricultural
experts**

409. Technical knowledge of agriculture is, we have now seen, the missing element in the existing agency of the Departments of Land Records and Agriculture. I shall, therefore, proceed to consider how this lack of technical knowledge can be best supplied.

It has been maintained by some who have turned their attention to this subject that entrusted to Department a Civilian at the head can be done. It is argued, the Botanical Survey, the Zoological Survey, the Marine Survey and others, the man of particular branch, and quite separate from the Department the Assistant being especially more likely to work out some improvement in agriculture than the present organisation.

I fully allow that there is a great deal to be said in favour of this view, and were the circumstances of India different from those which exist at present, there would be much to recommend it. Undoubtedly men trained in agriculture, and with a knowledge both of its science and its practice, would be much better qualified to deal with purely agricultural questions than the ordinary Civilian Director, just as it needs a geologist to deal with geological subjects, and a chemist with chemical ones. Could everything be reconstructed, and the whole system of administration in India be altered, this change would be one that I should recommend, but at the present time I cannot see that it is a feasible proposal, and so I do not advocate it. My work is to suggest what can be done rather than what ought to be done, and it is not for me to propound schemes which cannot, at present at least, be carried out. Besides this, agriculture stands on a different footing

The truths of phenomena may
nselfs, without
any direct reference to the people of that district. An officer of the Geological Survey, for instance, may pursue his enquiries qually in the gold mines of Mysore, the ruby mines of Burma, he evil measures of Bengal, or the oil districts of Beluchistan. le need be confined to no one locality, but may be drafted in suc- cession to each, and thus have no particular head-quarters. But whenever one attempts to deal with agriculture, he is brought at once into close relation with the people, their habits, their condition, and mainly their relation to the State as the supreme landlord. All questions of agricultural improvement touch upon the circum- stances both of the people and of the State, and it is impossible to divorce the two. Wherever he goes, the agricultural enquirer, as I know from my own short experience, will be brought face to face

with matters in which, not agricultural matters alone, but also the administration of Land Revenue is concerned. The Famine Commission recognised that agricultural progress was bound up with considerations of a Revenue character, and for this reason they did not recommend the formation of an Agricultural Department administered by experts alone. They hinted rather that it might be fit and necessary to associate with the Department the assistance of qualified experts. This is the opinion which I hold, too, although I would more strongly press the *absolute need* of obtaining this expert knowledge without delay. There are, as I have pointed out, duties other than those of being practical agriculturists which fall to the share of the Director of an Agricultural Department, and which could not be discharged by experts alone. Besides this, unless the agricultural expert be in complete touch with the Revenue authorities, and unless he have placed at his disposal the services of the Revenue subordinates, his progress in the way of agricultural improvement is hardly likely to be facilitated, or his position become an enviable one. On the other hand, if he proceeds to his work under the authority of the present Director, and in harmony with the Revenue authorities of a district, he is likely to be provided with all facilities in making his enquiries. These may seem points of small importance to one unacquainted with India, but to anyone who knows the country they are very material considerations. I must take India *as it is* and not as I think *it should be*, and my endeavour is, therefore, to graft improvements upon existing systems, rather than to suggest the subversion of the latter.

After giving much attention to this subject, I have come to the conclusion that the want of technical knowledge in the existing agency can best be supplied by the employment of *agricultural experts*, such as were contemplated in the recommendations of the Famine Commissioners and of the Government of India, and which are also indicated in the several notes presented to the Agricultural Conference at Simla, in October 1890.

If with the Director were associated one or more Assistants, who

pursue, under the orders of the Director, the practical work of enquiry. With the help of such an Assistant or Assistants the administrative ability of the Directorate would be supplemented by that knowledge of a special character which is required to enable it to deal with practical questions, as well as to carry on a continuous system of enquiry and, possibly, of experiment. The regulative skill and administrative qualifications of the Director would still be employed in seeing that the time of the Assistant was being usefully employed, and both enquiry and experiment would form a part of the work of the Department, *thus, until it may* it in reality one, not of Land Records only, but also of *agriculture*. Under the orders of the Director it would be possible, by a *series*

study of the requirements of a particular district and of its agricultural practices, to effect a transference of method from one part to another, or to introduce a new crop, or, perhaps, a new implement, and to pursue the other enquiries which I have sketched out in the earlier part of this chapter (*see* paragraph 400)

In this way I believe that the Department might be made of really practical benefit to the cultivator, as well as a necessary administrative branch of the Executive. It must, however, be clearly understood that to carry this out efficiently an Assistant must be free to employ his whole time in this work, and to pursue it among the people themselves, it would be inadvisable to have an enquiry conducted merely during the intervals of leisure from office duties, for, an enquiry once begun, must be continuous throughout. The men who are appointed must be those who would take up the study of agriculture as the business of their life, meaning to devote their whole attention to it. One fault of the past has been that when Natives have been employed in agricultural work they have not been taken from the right classes, nor have they had the training best fitted for them, so they have not regarded agriculture as their profession at all, but have waited for their chance of obtaining an appointment in some other branch, or of turning to the Law. Agriculture ought to be a distinct profession, and the man who enters it should prepare for it, intending to devote himself to it in just the same way as the Forest Officer enters the Forest Department or the Engineer the Public Works Department, that is, with the intention of remaining attached to that service. Agriculture, on the contrary, has had no permanent agency to carry on its work, and no staff of native subordinates who have been trained in it, or encouraged to continue in its pursuit.

410. The question now forces itself upon consideration. Ought the agricultural experts to be Europeans or Natives? Without attempting to lay down a rule to be followed in all cases alike, I would indicate my opinion that they should, by preference, be Natives, and Natives trained in India, not in England.

Frequent have been the attempts to provide the expert possessing agricultural knowledge, first, by sending home to England selected Civil Servants, to enable them to qualify, by a study of agriculture at Cirencester or elsewhere, for the Agricultural Directorship on their return; then by sending Natives who have graduated in the University, and allowing them to study agriculture in England, in the belief that on their return they would make useful agricultural officers. But neither plan has worked well as a whole, though in the case of the Civil Servants it must be said that they have fully justified their selection, and have shown the good results of the instruction given to them. But the study of agriculture at a College does not constitute a man a practical agriculturist, and unless the instructions be followed by practical experience on a farm it is not complete. Again, a man has to learn Indian and not English agriculture, and this cannot be taught at an institution like

Should
agricultural
experts be
Europeans or
Natives?

Cirencester College. There are further difficulties in the matter of furlough, and in the changes in tenure of the Director's office, which make it only occasionally desirable to equip a Civil Servant in the regular line with such special training in agriculture as would be obtained by a two years' residence at an Agricultural College in England. On these grounds, and because of the duties of the office being also largely administrative, I do not think it generally feasible to have the Director himself an expert agriculturist.

Some of the arguments advanced tell also against the employment of European expert assistants. They may have a knowledge of English agriculture, but if they begin to apply what they know, before they have studied the conditions of Indian agriculture, they will but repeat some of the many blunders which have made people in India doubt the possibility of improving Indian agriculture at all through the agency of English experts. It is true that in most cases the right men have not been sent out, and that the first lot of agriculturists (so-called) were nothing more than gardeners, and unacquainted with agriculture. But, whether from this cause or from others, a disbelief in the expert has, anyhow, been begotten. Other men of a very different stamp, such as Mr. Robertson and Mr. Deason, have been brought to Madras, and have laboured there under circumstances of, it must be said, a very discouraging nature, for they have received neither the sympathy nor support of their Government, and have been the victims of a continual change of policy on the part of that Government. Duties of office work, or of a tutorial nature, have prevented them from devoting themselves to strictly agricultural work, whilst a zeal on their part to introduce new implements and new methods has not been always moderated with the necessary caution in applying English to Indian agriculture. An Agricultural Department, the Director of which is purely a Revenue man, and who does not spend a certain portion of each year in camping about in his Province, is hardly likely to be in full sympathy with efforts made to improve the agriculture, and so it has proved to be the case in Madras. Now, at length, the conclusion is arrived at that it is first necessary to learn more about the methods of Indian Agriculture, and the Madras Agricultural Committee of 1890 have recommended the employment of experts to engage in the work of direct enquiry.

The chief points gained in selecting Natives as experts instead of Europeans are, firstly, that they start with great initial advantages in knowing the language, the habits of the people, and (if they be wisely selected) the conditions of agriculture and the methods employed, secondly, that the selection of Natives would be very much more economical. The advantages with which a Native starts are those which it would take a European a long time to acquire, and the latter would probably never be so closely in touch with the people as the Native expert. Occasionally it may be desirable to have one European expert Assistant to the Director, but this will be guided much by financial considerations.

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Should
agricultural
experts be
Europeans or
Natives?

and, if only the proper training be provided, I consider that the work may be done quite well by Natives. If a European be selected he should be a man who has gone through an agricultural course of training, such as is provided at Cirencester, Downton, or other Agricultural College, but supplemented (and on this I would insist) by practical experience on a farm. In the matter of salary the procedure adopted by the Forest Department with the men who pass out of Cooper's Hill College and who join the Forest Service might be followed, a similar rate of pay and increase, according to time of service, being given.

Where should
they be trained?

Training in
India preferable

It is, however, in the end, to the Natives that we must look to carry out the work of agricultural enquiry, and it becomes, therefore, important to consider how a training in agriculture may be imparted to them. This subject will occupy a subsequent chapter in my Report. Suffice it to say here that I am distinctly in favour of giving an agricultural education in India, rather than of sending Natives to England to study. Past experience has shown that the men selected for a European training have not been those whose associations and interests have been with the land, but they have been men of literary inclinations, who have graduated with distinction at the Universities. Their sharp intellect and wonderful facility in picking up any subject to which they devote themselves have made them apt students of the literature rather than of the practice of English agriculture, and in most cases they have tacked on a study of Law to that of the subject to acquire which they were sent over to England at Government expense. On their return to their country they no longer live as they used to, but adopt European ways and costume, more or less, and become generally discontented with the position which they occupy. In short, the residence in England has had the effect of spoiling them for occupying the position in the Agricultural Department for which they were intended to qualify, and they take to the Courts, sent home, ment, whi- fied with their position and prospects

On these grounds therefore, I strongly advocate a training in India for Native experts

The number of
Assistants

As to the number of Assistants which a Director would require, this must vary in different Provinces, and according to the work to be done, but one for each Division would probably not be more than would eventually be found useful. As the essence of success turns upon the acquirement of local knowledge, the Assistants must of necessity be provincial, and not be removable from one Province to another like the Director

I would add here that care should be taken in the selection of experts, so as to choose, as far as possible, men from the agricultural classes, and such as have an interest in the land, and who have lived amid agricultural surroundings. Too often men have been taken from the ranks of those who, as a rule, follow the

profession of the Law, and who do not regard the pursuit of Agriculture as in any way a profession.

411. I have now discussed in considerable detail the question of the training of experts, and would conclude by expressing my views (subsequently only confirmed by the Conference at Simla, in October 1890, they received a very general approval, expressed in the terms of the two following Resolutions passed at the Conference—

*Views of the
Agricultural
Conference at
Simla, 1890.*

First.—“That, in the opinion of this Conference, it is essential, for the proper performance of the duties imposed upon the Agricultural Department in this country, that the Director of the Department should be an Assistant or Assistants who are experts in the practice and theory of agriculture.”

Second.—“That it will be preferable to train Natives to be qualified for the post of Assistant in the Agricultural Department in this country rather than in Europe, and that this end cannot be attained unless there be a high-class education established in this country.”

CONCLUSIONS.

412 Before any real improvement can be effected in agriculture, the institution of organised enquiry into existing methods and conditions is absolutely necessary. Thus far, little more has been done than to collect statistics and information as to the liability of districts to famine. The expressed opinions of the Famine Commissioners and of the Government of India have clearly indicated that more than this was intended, and that enquiry into agricultural practices was recognised as a preliminary to agricultural improvement. The time has now arrived when practical agricultural enquiry should be initiated. The principal directions in which enquiry should proceed are, firstly, the obtaining of definite information as to the requirements of each district in the matter of supply of water, manure, wood, and grazing, secondly, the study of agricultural practices, with a view to the transference of the better methods to districts where they are not known.

The agency which Agricultural Departments possess at present is inadequate to carry out such a system of enquiry, and a technical knowledge of agriculture is a necessity.

The Directors of Departments of Land Records and Agriculture are principally occupied with administrative duties and have neither the time nor the technical acquaintance with agriculture which would enable them to devote themselves to the subject of agricultural improvement. Further, the constant changes in the tenure of the office of Director prevent the continuity of any experimental enquiry.

While, for administrative reasons it is desirable to retain the Director of an Agricultural Department in his present position, the want of technical knowledge of agriculture must be supplied, this can best be done by associating with the Director one or more expert Assistants who will make agriculture the business of their lives, and whose duty it will be to investigate, under the Director's orders, the agricultural conditions of the different districts of a Province. The men selected as agricultural experts should be, by preference, Natives who have been trained in India

RECOMMENDATIONS.

RECOMMEN-
DATIONS.

413. That a definite system of organised Enquiry into agricultural conditions and practices be instituted forthwith.

That a Permanent Agency be established for this purpose, and consist of the association with the Director of the Department of Land Records and Agriculture of an Assistant or Assistants who are trained experts in agriculture.

That such experts be, by preference, Natives of India, and be trained in the country itself.

That high-class Agricultural Education be provided in India so as to train the men who are to become agricultural experts.

CHAPTER
XVII

CHAPTER XVII

SCIENTIFIC AGRICULTURAL ENQUIRY

SCIENTIFIC
AGRICULTURAL
ENQUIRYThe connection
of science with
practice

414. THE important services which science has rendered to agriculture, and the marked development of the last half century is to practice.

It is the domain of science to explain the principles which underlie good practice, and to extend the application of these principles, as well as to make fresh discoveries that may be of benefit to agriculture. The work of improvement, had it proceeded simply from the practical side, would have been, as it has always been, slow, but when science set to work to find out the causes of well-ascertained facts in practical agriculture, progress at once became rapid.

The application of science to practice may be briefly described as follows:—The facts and the discovery of their principles have been discovered, and the developments of practice, and to new discoveries. I might briefly illustrate the importance of scientific investigation in regard to practical agriculture by referring to the difference between the state of our knowledge at the present time and that which existed prior to the introduction of scientific enquiry.

Formerly, it was enough to know empirically that certain practices were good, that certain kinds of soil were suited to particular crops, that certain foods were useful for cattle, but no one could say more than that these things *were* so, and not *why* they were so. Now, however, the connection between soil, air, plant, and animal has been worked out, and our knowledge is being continually added to, we know, in great measure, what plants are composed of, whence they draw their nourishment and in what forms it must be supplied to them, what the constituents of food are, and the changes which they undergo in the animal economy. We are enabled thus to provide for the needs of field crops by suitable manuring, to repair the demands made upon the soil, to feed stock on a rational system, and to cultivate the land on other than stereotyped lines. Distant countries have been put under contribution to supply manurial resources for our crops and food for our stock. In short, a definite knowledge of the processes taking part in the growth of the medium of life is going on in agriculture. I will go a long way to explain much that has so far not been understood in agricultural practice, and may also have important bearing upon the practice of the future.

The results of
enabling
science and
practice

Practical enquiry will always be needed to keep up the knowledge of what is being done, and to provide a field for scientific enquiry; but it is, nevertheless, from the latter that, wherever it is possible for development to take place, any great future advance will be made.

415 The above remarks have been made in reference to agriculture in general, and not to Indian agriculture in particular. I have shown, indeed, in earlier chapters, that the conditions of agriculture in India are such as to greatly limit the possible scope for improvement, and, consequently, to narrow the field for the application of scientific enquiry. As Mr Tuselton Dyer points out, the special conditions of India limit the field of scientific enquiry.

landowners
movement by
alth to carry
never have
instigated such enquiry, although they were not slow to adopt its results when they saw that it paid. The non-existence in India of any class corresponding to the resident English landowner of intelligence and wealth is a bar to the progress of original agricultural investigation, and will limit the pursuit of enquiry to such matters as seem to have a direct bearing upon the immediate well-being of the people. Further, the smallness of the holdings, the paucity of capital, the habits and prejudices of the people, and the financial obligations of the Government, are bound to impose obstacles which would not present themselves to such a degree in other countries.

together, and for advocating its pursuit whenever practicable.

Primarily, let me say that, if practical enquiry is to be successful, it must be scientific in its methods, it must proceed on a well-regulated plan, and its results must be submitted to careful and critical examination. The mere collection and record of facts is not enough, they must be put into a connected and useful form, and they must be verified by experiment. Such work as this cannot be adequately performed without the possession of a scientific training of mind by those to whom it is entrusted. So far as India is concerned, I regard the proper regulation of practical enquiry, and the examination of its results, as one of the most useful ways in which scientific knowledge may be applied to the practice of agriculture.

417. While acknowledging the bearing of sciences such as Botany, Geology, Physiology, Engineering, and Meteorology upon agriculture, it is Chemistry more than any other that has been prominent in the past, and from agriculture, the greatest

Moreover, it is with the application of chemistry to the improvement of Indian agriculture that the present Report is largely concerned.

Such rapid strides, however, has the science of chemistry made within recent years, and so widely has it ramified into almost all branches of industrial occupation, that agricultural chemistry, or the application of chemistry to agriculture, has become a branch by itself, involving separate and special study. It will be my business, in the remarks that follow, to see how agricultural chemistry may be most usefully brought to bear upon the improvement of agriculture in India.

418. The need of bringing in the aid of agricultural chemistry to the problems of Indian agriculture has been admitted on many

the Geological Survey, writing in 1877 upon the "Rich" enquiry, said—

"Observation and experiment cannot be profitably made by men, however otherwise intelligent, without any scientific knowledge of the matter under investigation. I would therefore advise that a well qualified agricultural chemist be engaged . . . under the Department of Agriculture to devote himself to this special investigation."

The need of an agricultural chemist was foreseen by the Government of India in 1881. In their Resolution of December 1881 they said:—

"Finally, the science of agricultural chemistry will be demanded for the solution of many important agricultural problems."

In 1883 the Government of India formed a strong opinion that there should be an agricultural chemist for the Northern Provinces, and mentioned the vast unculturable tracts that existed on account of the occurrence of soda salts which impregnated the soil. They considered that the aid of science might reclaim these lands. Consequently in their Despatch of 8th February 1883, they asked the Secretary of State to sanction the appointment of an agricultural chemist who could be used for this work and for educational purposes as well. It was proposed to establish an Agricultural College in the North-West Provinces, and to attach an agricultural chemist to it. The Secretary of State refused the application on the ground that the matter was a provincial and not an imperial one.

however, while allowing the importance of the matter, has expressed himself as not satisfied with the methods proposed

The Conference of Agricultural Directors at Simla, in October 1890, expressed their opinion that there were an enormous number of questions which they (the Agricultural Directors) wanted

Opinions as to
the desirability
of having an
agricultural

Government of
India, 1881.

Government of
India 1883.

Government of
India 1884,
1885, 1886.

Agricultural
Conference
October, 1891

to be answered, and which only a chemist could answer . . .
 "it was self-evident that an agricultural chemist was needed for
 "India, just as the Royal Agricultural Society of England found
 "that one was needed for them . . . a chemist was needed for
 "investigation, and as a referee, quite apart from the question of
 "education."

Sir Edward Buck, in conversation with me, succinctly stated his opinion that all attempts at agricultural improvement must have for their basis some scientific groundwork, and as chemistry is the science that comes most in contact with agriculture, he considered that an agricultural chemist, to act as an agricultural expert, is the man most needed and most important.

419. In the preceding chapters I have, when dealing with each subject in detail, taken occasion to point out where the assistance of an agricultural chemist could be usefully employed. I

Sir Edward Buck, 1890
 Scope for work of an Agricultural Chemist.

various soil constituents; the nature of alluvium and black cotton-
 in the soil; the amount of
 atmospheric nitrogen by
 plants as well, and their
 , and
 water
 water,

butter (ghee) and other dairy products, the causes which affect the out-turn of sugar, the investigation of the chemical changes which take place in the manufacture of indigo, and the parts they respectively play in influencing the produce, the examination of suggested improvements in indigo manufacture, the influence of manuring upon the cultivation of tea, the investigation of the processes employed in the manufacture of tea; the manurial treatment of coffee; the curing of tobacco.

420 But there are other duties which an agricultural chemist would be called upon to discharge, and these, while somewhat of a different nature to the above more independent and great economical importance in the nursery and experiment. It allows regulating, and watching progress of enquiry and experiment, and of critically examining and systematically recording the results obtained. My own experience

work has been begun, but no one has been charged with the oversight of it, it has been always a matter of personal choice and inclination, and what has been no one's duty, has, after a time, too often been neglected and lost sight of. An agricultural chemist of the type I have suggested might, on the contrary, be definitely charged with the duty of maintaining the continuity of experiment, of watching its progress, of suggesting its development, and of examining and collating its results in useful form. In some such way alone can experiment be carried to a successful termination, and the work is one which might well be conducted by a man possessing a fair practical knowledge of agriculture combined with a more special one of chemical science and scientific methods.

In the course of my tour I went to see an experiment on the reclamation of ravine land by means of embanking (*bunding*)* it so as to hold up the water, and thus provide water and irrigation. Wells were hard to dig, the water-level being low and the ground rocky. One object of the enquiry was to see if the water-level of the country would be raised by the embanking of the land. On enquiring whether any rise had resulted, I found that it was impossible to tell, for, either the level at starting had not been taken, or, if taken, it had not been recorded, at all events, no one at the Station knew about it. This does not require a chemist, it is true, but it is an instance of what will happen over and over again in India unless work of enquiry be entrusted to men of a scientific turn of mind, and also be put in the hands of a continuous and responsible agency, and not be left to amateur and spontaneous efforts.

422 Another function which an agricultural chemist of standing could usefully serve would be that of acting as a "referee" or "Government adviser" in chemico agricultural matters. There ought certainly to be someone in India who would be able to give an authoritative opinion on points where the relation of chemistry to agriculture is concerned. The advantage to Government of having someone to whom they might confidently turn for guidance in chemico agricultural matters, involving, as they often do, very considerable expenditure, needs no demonstration. Nor, again, is it necessary to explain how very useful such an adviser would be to the Agricultural Directors of the different Provinces. Without having the power of interfering in

of any experimental enquiry

Associated with such an office would be the duty of adding to chemical knowledge respecting the food products, crops, and other resources of the country, a work which has, so far, been but very imperfectly done.

423 Lastly comes the
in connection with the dev
Though not proposing, as I

Let me say
Chemistry
for a general
scheme of Agricultural Education, I by no means wish it to be
regarded as indispensable for agricultural improvement under the
conditions that exist in India. That there should be someone who
has a good and practical knowledge of Agricultural Chemistry I
certainly consider a necessity, but I do not imply that it will be
necessary to spread instruction in that particular branch of science
in order to achieve any success. The mere teaching of Agricultural
Chemistry will not in itself create agricultural prosperity, though
it may open the mind, and lead to an understanding of the
principles upon which practice is based. In its methods it is
explanatory and regulative rather than creative. In India there

The teaching of
agricultural
chemistry

opportunities in England of judging how this is likely to be the
case, having had experience as an examiner of Indian students who
have come over to study agriculture at Cirencester and elsewhere.
With wonderful powers of getting up any subject to which they
apply themselves, and with marvellously retentive memories,
they are able, by their accurate replies to the questions set them
in an examination, to acquit themselves with credit and distinction,
nevertheless, to an examiner who has them before him for *visà voce*
examination, it is apparent that there is not that practical under-
standing of the subject, and that grasp of it, which are likely
to lead to future benefit as the result of the study. The knowledge
which these Indian students possess presents itself to me as that
of a subject studiously and carefully got up with the aid of great
natural abilities, but which remains merely as an impression on the mind
for a time, and which fails when the call comes for its application
to practice. Therefore, I do not look for great results to follow at
once the introduction of the teaching of Agricultural Chemistry,
made for it on any
should be one or two
Agricultural Chemistry
For the right co-
its development when
e responsible.

In another branch of educational work the "scientific adviser"
could render useful service. This is in the preparation of a text-
book or text-books on Agricultural Chemistry, which shall be
specially adapted to the case of India. At present there is no such
book existent, and though it is true that the principles of a

Preparation of
text books.

science remain true everywhere, yet it is in the judicious illustration of principles by practice that the chief value of teaching consists, besides, the conditions and practice of Agriculture in India are so different in those in England as to make the adoption of English text books undesirable. The "scientific adviser," again, would be able to do good service in an educational direction, not alone in the preparation of a text-book of Agricultural Chemistry, but also in aiding the issue of text books on Practical Agriculture throughout the different Provinces of India. By the co-operation of the *agricultural experts* (referred to in the last chapter) with the "scientific adviser," a series of agricultural text-books specially adapted for particular Provinces or districts might be issued, and would greatly aid the spread of sound knowledge of agriculture and of its underlying principles.

Summary of
duties of
scientific
adviser

424 The principal functions of a "scientific adviser" in agricultural matters should, it appears to me, be as follows —

- 1stly To act as a referee or adviser to Government in all chemico agricultural matters
- 2ndly. To direct and maintain the continuity of experimental enquiry into Agriculture.
- 3rdly. To compile and publish the results of experiments, and to show their practical bearing
- 4thly To make independent scientific investigation upon agricultural questions.
- 5thly To direct the teaching of Agricultural Chemistry, and to assist the spread of Agricultural Education, by the preparation of simple text books

The qualifications
necessary
in a scientific
adviser

425 I have now explained my reasons for believing that there is call for an agricultural chemist in India, and I have also mentioned what I think his chief duties should be. It becomes now necessary that I should set out in detail some considerations which it is imperative should be attended to, if any good is to result from an appointment such as I have suggested.

In the first place, a man fitted for carrying out the duties indicated above must be a man of high scientific attainments, capable of giving an authoritative opinion on points where Agricultural Chemistry is concerned. He must, accordingly, be especially a good scientific and practical agricultural chemist, able to conduct scientific investigation and to carry out the practical work of an analytical laboratory. But he must be more than this, it is necessary that he should have a good general acquaintance with practical agriculture. I do not say that he must be a practical farmer, this is not what is required, but he must have had that acquaintance with it which shall enable him to understand its methods and requirements, and thus usefully to bring his scientific knowledge to bear upon its development, in short, it would not do to have a pure "scientist," or a man who simply buried himself in his laboratory, and carried on investigations

which had no direct bearing on Agriculture as actually practised. The investigations pursued should be those based upon the actual practice, and their direct intent is to be the bettering of that practice under *existing* and not under *ideal* circumstances. It would be necessary, therefore, to carry on investigation in the light of an acquaintance with local conditions and requirements. In some ways, then, it is rather the scientific agriculturist than the "laboratory chemist" that is required, inasmuch, however, as the attainment of high *chemical* knowledge of agriculture is a necessity, and can only be obtained by previous special study (for which the practical agriculturist has not the opportunity) the agricultural chemist is the man primarily needed. He must, however, be one who is able to add to his scientific attainments a good general acquaintance with agricultural methods and conditions. As one of the delegates to the Agricultural Conference at Simla, in October 1890, said, "We want . . . a man who is at once a good chemist in the laboratory and acquainted with practical farming on its scientific side," this, it seems to me, fairly describes the kind of man who is wanted. He must be a man of business habits and capacity, and also sufficiently practical to be able to supervise experiments, and to go round and see what subordinate officers are doing, whether by way of experiment, enquiry, or teaching.

426 The next question that arises is, whether one such man is sufficient, or whether several are required. I am decidedly of opinion that, at the outset, *only one* agricultural chemist is wanted, inasmuch as this scheme must be regarded as more or less experimental. As I have pointed out already, I do not regard the want of an agricultural chemist as a necessary part of the work of agricultural improvement, all

The number of such men required

be a very necessary part of the work of improvement. Therefore, I would prefer to begin in a moderate way and not to commit Government to more than a tentative scheme, the further development of which would depend upon the success achieved by the initial one. I do not deny that the suggested scheme is inadequate to meet the requirements of the country and of the different Provincial Governments, but it is all that, under present conditions, I feel justified in recommending, *viz*, the appointment of one first-class man to act as Government referee and adviser. For a complete scheme it would be desirable, I think, to have an agricultural chemist in each Province, or, at least, in each of the three Presidencies, Bengal, Bombay, and Madras. But it would be better to begin with one man, and if the necessity arose, and the desirability of

If one man, imperial, but any Provincial

Government which might wish to avail itself of his services would be entitled to do so and, thus, his functions would be rather national than imperial

Necessity for
extended time
and oppor-
tunity of
study to be
given to a
scientific
adviser

427. The third point upon which I would insist is, that if any appointment be made, there must be sufficient time allowed to see whether the experiment (for such I must term it) has succeeded or not, also the man so appointed must have time and opportunity given him for acquainting himself with the methods and conditions of Indian agriculture. A man, be he ever so good an agriculturist, cannot be expected to become conversant with Indian agriculture over a short period of time.

him the opportunity of becoming conversant with Indian agriculture. In fact, he will almost have to forget, for the time, what he knows, and start afresh as a learner. To attempt to teach or to improve agriculture without first becoming acquainted with its conditions is to court almost certain failure. I am only too well aware that whatever I have been able to gather during my own tour has been the outcome of those facilities which were so readily placed at my disposal, and of which I have availed myself with the view of acquiring as much knowledge as possible of the agriculture practised in different parts of the country. But, while the new comer will do well to regard himself for some time as a learner, it is equally incumbent on those to whom the giving of such an appointment is entrusted, that they should be content to exercise patience, and that they should allow time for the chemist to get that practical acquaintance with Indian agriculture which is essential to his after success. To bring a man of scientific attainments over to India, and to set him down to work on plans of experiment, or to engage in investigation, before he knows anything practically of the agriculture of the country, is to ruin the project from the very outset. The history of past efforts at agricultural improvement abundantly illustrates this, and the men who have been located in one spot, and have been set to work on improvements from thence without going about and acquainting themselves with the country, have proved of but small value. The real blame, however, attaches not to them so much as to those who have called upon them to "make bricks without straw," and have asked them to write Reports, conduct experiments, and, in short, to justify their appointment, long before they have had an opportunity of providing themselves with the knowledge necessary for the useful discharge of the duties which have fallen to their share. I may be putting this very strongly, but I am well aware of the need of so doing, for the error is one that has been repeated over and over in the past, and I am anxious that it should not be committed again in connection with the possible appointment of an agricultural chemist. I would, therefore, strongly urge that, unless it be clearly

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make any appointment at all. If, however, time be allowed, patience be exercised, and opportunities of gaining experience be given, the proposed plan will have a fair chance, and should it then be found

to fail, it will fail either on its merits or because of the deficiencies of the individual. If the former be the reason, it may fairly be said that the experiment has been tried and has failed, and it will remain as an experiment of not too extensive or over costly a nature if the individual prove unsuitable, he can be replaced. It is not possible to define exactly what number of years should be allowed for the experiment to be on its trial, but the general opinion expressed at the Simla Agricultural Conference in 1890 was, that not a less period than seven years should be named for the duration of the appointment. This appears to me a fair term to fix. It would not be necessary, as it was in my case, that the man appointed should take at the outset a hurried view of the whole agriculture, but it would be quite feasible to select some typical district for special study each year, and to devote a certain time to travelling about to other parts.

428 A necessary part of the equipment of a "scientific adviser" is that he be provided with a laboratory suitable in every way for the carrying out of analytical work and of investigation. This at once opens up the question as to where such a laboratory should be placed, and how the work there is to be conducted. With this is bound up the consideration as to whether the "scientific adviser" is to be directly engaged in the work of teaching or not. This I have
that th
rather

The "scientific adviser" is to be primarily an investigator not a teacher.

the routine duties of teaching. If a man is to be the instructor of such students as would attend an Agricultural College, he would of necessity have to be located at some one fixed place, for a part of the year at least, and certain duties of a routine nature would be expected of him. This, in the case of India, would, to my mind, interfere altogether with his usefulness as an investigator, and as an adviser to Government. It is more than probable that his presence would be required in some part far away from his teaching centre just at the time that the course of instruction he was conducting was going on. I am not at all disposed to favour the employment of investigator and teacher kept quite distinct to move here and there as might be required, and should not be tied down to any one place in particular.

At the same time, as I pointed out before, he should not allow the work of giving instruction in agricultural chemistry to pass out of his control, but he should direct it, and be responsible for its efficiency. It would be very desirable also that he should, from time to time, as opportunity permits, give occasional lectures or short special courses of lectures, at different centres throughout the country.

429 Although I would not fix any definite centre where the "scientific adviser" is to work, he must clearly have a good laboratory or laboratories at his disposal. There must also be some place or places to which applications may be addressed, and with

The need of a good laboratory and of an assistant chemist in charge of it.

which he shall remain in communication. Suppose him to be engaged in an enquiry upon *salty land (usar)* reclamation, he may have samples of soil, or of water, or of salts, to analyse in pursuit of the investigation. These cannot be analysed on the spot, but would have to be referred to a laboratory, and be done either by him upon his return, or, in the meantime, by some one working under his instructions. This leads me to consider the desirability of having a second man as assistant to the "scientific adviser." This I would recommend on two main grounds, firstly, the advantage of having a resident analyst to carry out the details of work conducted in a laboratory, secondly, the advantage of being able in this way to provide for the teaching of agricultural chemistry at certain fixed places.

In the work of investigation and enquiry there will be numerous analyses to be performed, and purely analytical details to be carried out, all involving care, skill, and special chemical training, but yet more or less routine in nature. It is not necessary, nor even desirable, that the time and qualifications should be taken up by a man who can be helped, but it should be so arranged that which he alone can do. It is also very desirable that analytical work connected with any enquiry should proceed without interruption, until the enquiry is completed.

If a man could return, and then had to carry out all the analytical work with his own hands, there would soon be an accumulation which it would be hard, and often impossible, to overtake, and he would often be prevented, too, from taking up other work that calls for his special employment. If, on the other hand, there were a second man, or Assistant Chemist, as I may best term him, acting under the directions of the "scientific adviser," he would be able to carry out all the analytical details, and present them to the senior chemist for his utilisation on his return, or for forwarding to him if still away. Further, the presence of an assistant chemist resident where the laboratory is, would ensure someone being on the spot, ready to attend to any analytical work required by Agricultural Directors, or for Experimental Farms, or to transmit anything for reference to the senior chemist. A constant communication would thus be maintained between the "scientific adviser," and the laboratory where his work is conducted, as well as with those who might wish to apply to him.

But the second advantage to be gained by the appointment of an Assistant Chemist is also a very important one, inasmuch as it appears to me to provide for the educational want which the Government of India represented to the Secretary of State, and it at the same time meets the very proper objections of those who urged that an agricultural chemist should be used for purposes of investigation, and not directly for teaching. With an assistant chemist resident at some centre where a laboratory is placed, the

teaching of Agricultural Chemistry at that centre might perfectly well be provided for. The assistant chemist, while engaged in his laboratory duties during part of the day, would be quite well able to give lectures on Agricultural Chemistry to students, and, from time to time, to conduct a class in practical laboratory work. The need that has been felt of late of providing a higher class of instruction for Native Forest subordinates emphasises the desirability of giving, in some such way as I have suggested, a training in Agricultural Chemistry as part of their Course.

A third advantage would follow such an appointment. The changes, the leave takings, etc., necessitated by a residence in India, oblige the provision of a substitute to take the place of an absent officer. Should this be the case with the senior man, it would certainly be an advantage to have an assistant chemist who, while working under the senior man, would be able to take his place in his absence, and thus not allow his work to be at a standstill. It may be necessary, perhaps, at some future time to fill a vacancy in the higher office, and it might be found better to promote the junior man to the senior post and utilise the knowledge of India which he has already gained, rather than to make a quite fresh appointment, and to bring over a new man who would first have to go about and learn the agricultural conditions for himself, as his predecessor had done.

430. The qualifications of an assistant chemist must primarily be —

1stly, That he be a competent Analytical Chemist.

2ndly, That he possess aptitude for teaching, a good general knowledge of science and sufficient special knowledge of Agricultural Chemistry to enable him to impart instruction in it.

431 It must now be considered where the laboratory and the assistant chemist are to be located. It is naturally desirable that special work, such as is here involved, should be carried on under as favourable conditions in regard to climate and situation as is possible. But, at the same time, a laboratory should not be so isolated as to fail to be of benefit to India as a whole. As the "scientific adviser" is to be imperial, this might be a reason for his being attached to the Government of India, and for changing his locale when they do, so that he might be available when his advice was needed. But, though it may be desirable to have the "scientific adviser" in touch with Government, I would rather see him peripatetic in character, and have him go about the country wherever and whenever required. Besides, neither Calcutta nor Simla appear to me altogether desirable places at which to establish a laboratory, certainly not for a whole year. Calcutta is quite at one corner of India, and, in regard to climate, is not suitable all the year round, while Simla is also too far removed from the rest of India, and is not likely to form a good educational centre. I confess my own predilections for choosing,

An assistant chemist to officiate in the absence of the senior officer

The qualifications of an assistant chemist

The location of a laboratory

were it possible, some place which, while being agreeable on the whole, as regards climate, might be as central as possible, and hence available for the different parts and Provinces of India. Jubbulpore, for instance is such a place, and had there been any suitable institution available there, I might have recommended its adoption as the location of the laboratory, and as the headquarters of the "scientific adviser" and his assistant chemist. Students from all parts of India would readily be able to come to such a centre, whilst it would have further advantages in enabling "the scientific adviser" to make it a good starting point for his various journeys to different parts, whether north, south, east, or west. But I am not prepared at this stage to advise the building of any institution specially for this purpose, but, as the whole scheme is an experimental one, I think that it would be better to utilise those facilities which already exist, and to provide, as far as possible, for the development of scientific education at places where it has already obtained some foothold. Agricultural Colleges are represented principally by the institutions at Saidapet (Madras) and the College of Science at Poona (Bombay), to omit the more recently established one in the Native State of Baroda. In addition to these institutions at which instruction in Agriculture is given, there is the Forest School at Dehra (North West Provinces). The training of Forest Students is also carried on at Poona, students coming here from Madras and Southern India generally, whilst Dehra is intended to serve the purposes of Northern India. It was in connection with the development of the Forest School at Dehra that the application first came for the appointment of an agricultural chemist for India, and, though I do not see my way to recommend the appointment of a special officer for that purpose, I certainly see a decided advantage in having a laboratory or laboratories placed where they may be utilised by Forest Students, and where their presence will include also the services of a man capable of imparting instruction in Agricultural Chemistry. At Dehra there is already a very fair laboratory, which might quite well be adapted to the new requirements, this would serve for the North of India. At Poona there is a very good laboratory also, and, besides being the centre of the agriculture of the Deccan, Poona has the further advantage of being a pleasant place during the rains. In the course of enquiries that were made when the idea of having an agricultural chemist was first suggested, it was elicited that Madras would be satisfied to send its students to Poona, and if this plan were carried out, Poona might serve for Bombay and the whole of Southern India. After careful consideration, I think that the best plan would be to have the headquarters and laboratory fixed for six months of the year at Dehra, and for the other six months at Poona. In this way the need of imparting instruction in Agricultural Chemistry would be met for both Northern and Southern India, and, at the same time, the work of investigation would be able to proceed under fair climatic surroundings. The Forest Students, both of Northern and Southern India, would be able to receive instruction, as well

as the Agricultural Students attending the Poona College; existing laboratories would be utilised, and, altogether this scheme recommends itself as being the best to meet existing wants.

432 It seems necessary now to say a word as to the duties of the "scientific adviser," and of the assistant chemist. I would lay it down, as regards the first named, that he must be given a free hand, and that no one, and no Department, exercise more

Duties of the
"scientific ad-
viser, and assist-
ant chemist"

It is impossible to lay down the exact employment of his time.

his appointment is justified, after due time has been given him to get into his work, but, unless confidence be placed in him to rightly employ his time and opportunities, the appointment is almost sure to end, as many have done before, in not realising what it was intended to. I hope, therefore, that if any such appointment be made, the holder will not be called upon at an early date to "justify his existence,"

as the result of his appointment is to show, at the end of his continuation is to show this with having

to prove that he is "earning his salary" and usefully employing his time, unless, of course, circumstances should arise which would call for his removal on personal or other unquestionable grounds.

With regard to the assistant chemist, his duties must be laid down by the senior chemist, whether it be the carrying out of laboratory work or of instruction, and for the proper discharge of these duties the senior man must be responsible.

Should a "scientific adviser" be appointed, there is little doubt that several industries such as those connected with indigo tea, coffee, sugar, etc., would be desirous of availing themselves of his services, and the question arises whether he should be allowed to undertake private work and to receive emoluments from private individuals in addition to his official pay. It may, with much reason, be urged that industries such as the above contribute materially to the country's welfare, and that their prosperity is co-incidental with that of the cultivators and labourers employed in them, so that Government should assist in improving the different manufactures by giving the help of their scientific experts. That these industries could be improved by chemical knowledge and skill being directed to them I have no doubt, but there are, it seems to me, great objections to the utilisation of a Government agricultural adviser in technical work when there is so much to be done in a more purely agricultural direction, and when not one district or Province alone is concerned, but the whole of India. To properly take up such an investigation as, for instance, that of the improvement of indigo manufacture, the whole time of an expert scientist would be required, and for much more than a single year. Then it might be asked,—to which of the several industries should attention be turned first of all? My view is that each of these industries should employ its own experts,

The scientific adviser should not be allowed to engage in private work as well

and should not look to Government for this. There is quite enough to do in each to occupy special men if selected, and what could be done in a casual way by a man engaged in general agricultural work in other parts of the country would count for but little. But there are other dangers attending the employment of an agricultural chemist in technical investigation. It is only to be expected that if a man be free to take up private work he will choose that which pays him best. More especially will this be the case if the salary attaching to the office be put at a low figure, on the ground of the chemist being able to increase his remuneration by doing outside work. I would point out, moreover, that the inducement to seek private practice will tend to make a man neglect the more special work of his office, and if Government appoint an agricultural chemist with liberty to engage in other work for payment by private individuals, they must not be surprised to find their man select such work as is most remunerative to him, and engage in technical investigations rather than in the direct improvement of general agriculture. Whoever he be, a man is sure to pick and choose what he will like to take up, and liberty to engage in private work will, in cities. There is for having no scientific skill a toffs, manures, etc., for, practically, no such trade exists in and so. It would be far better to pay a man a high salary and let him look for nothing beyond it, than to have him, while in receipt of pay for doing agricultural work, endeavour to increase his income by engaging in outside investigations.

However, I would by no means say that if Government thought it advisable that their chemist should take up any investigation concerning a technical industry, he should not be at liberty to undertake it. But it should not be, I think, for any extra remuneration, and it should, in every case, come to him as a reference from Government, and with the request that he would, if able to do so, take up the matter in question. Any fees received for the work should go to Government. For the reasons I have given above, I do not think that any such investigation can be of a

Similarly, I should be inclined to object to the employment of the "scientific adviser," or of the assistant chemist, by Municipalities, for their local purposes, or in the multifarious duties of the office of Chemical Examiner. Such duties are not primarily agricultural, and should be left to men specially appointed to carry them out.

433 It is necessary that I should now say a few words as to the salaries to be paid to the respective officers whose appointment I suggest. Seeing that so much depends upon the standing of the men who are selected, and also upon whether a pension be

* Scientific adviser not to be appointed for Municipalities or as Chemical Examiner

The salaries of the scientific adviser and assistant chemist.

or be not attached to the respective offices, it is not possible to say definitely what a proper remuneration would be.

For the senior position, either a man of established reputation and recognised scientific standing may be obtainable, or also the man to be selected must be a somewhat younger man of undoubted ability and great promise, but who has still a name to make for himself. In the former case, I do not think that, leaving out the question of pension, a lower salary than Rs. 2,000 a month, rising to Rs. 2,500 a month, should be given. If a younger man is sought, then a salary of from Rs. 1,250 to Rs. 1,500 a month would be sufficient. These amounts depend much, of course, upon the rate of exchange taken as the basis; when I stated them in India the rupee was then at 1s. 0d., but it has since fallen considerably. It will be clearer, perhaps, if I say that I think the salary of a man of established reputation should be about equivalent to 1,800% a year, rising to 2,250% at the end of the term of 7 years; or, in the case of a younger man, about 1,200% a year, rising to 1,500%. It would be better, however, to do as the Agricultural Conference at Simla in 1890 recommended, and to leave the exact salary to be determined by the Secretary of State, and to be dependent upon the class of man ultimately selected.

As regards the salary of the assistant chemist, this, too, must be regulated to a certain extent by the turn which exchange takes, but a salary which is equivalent to 550% a year, rising to 700% a year, should be sufficient to attract a suitable man.

434. There are other matters of detail which might have to be considered in making the above arrangements. One of these is, whether the officers under the selection should be selected from India, or be brought out from England, Germany, or elsewhere; and by whom the selection should be made. On the first point I can hardly offer an opinion; but as to the second, I am almost sure that it will be necessary to go beyond India to find a man of the required standing. The selection should be made by the Secretary of State, or by a committee of experts, such as the Royal Agricultural Society of England.

While an assistant chemist will be readily obtainable, I am well aware that it will be no easy matter to find a man in every way suitable to fill a position of the kind which I have sketched out. I have found who would be suitable, but the position is not so readily discovered. In the end it may be necessary to select a man of the required scientific qualifications, and who appears likely to be able to develop the practical qualifications after he has acquired them. I am not sure that it is possible to find a man of the required standing beforehand. I am certain that the "scientific adviser" is to be an authority on chemico-agricultural matters,

the primary requirement is that he shall have gained the special experience before coming to India, and if he be a man of ability, he will be able to see what is his knowledge to his scientific ability.

I am conscious, too, that it may be said that in giving a man so free a hand as that which I have suggested he should have, I have left a good deal open to him, and have put but little control over him. It is quite true that this leaves much to chance. If a man be active and devoted to his work he may make his position one of much value, and render its continuation indispensable; if, on the other hand, he only studies his own comfort, he may simply make his appointment a "cosy berth" which brings him in a good salary, so long as it lasts. It is so difficult, however, to impose any system of control without at the same time destroying the practical usefulness of the appointment, that I think it is better to rely upon the individual to show that his selection and the creation of the office have well been warranted.

The employment 435 I should be misunderstood if I were supposed to imply enquiry in India
mist The branch chemistry, and so

I have spoken mainly from the standpoint of the chemist. But there is need of men expert in other branches of science too. Among these, a Botanist, an Entomologist, and an Agricultural Engineer might be mentioned. Such men may be found in India itself, and from time to time their services have been utilised, but,

assistance available, and there are, as I have said, men in India fully qualified to give this, whereas this is not the case as regards the field is open, too, for the study of the various diseases and insects. Already, at the Forest School, Indian Museum, Calcutta, has been employed in giving a course of lectures on this subject. So far, this is good, but it only covers a period of six weeks in the year, and Mr. Cotes has the general duties of his appointment at the Indian Museum to attend to as well as the more agricultural relations of the subject. I heartily approve of the employment of men of attainment in different branches of science for the furtherance of agricultural knowledge, and also for teaching purposes, but this must be done on a more extended scale than has been the case up to now, and there should be, as I have said, both

a Botanist and an Entomologist attached regularly to the Agricultural Department

A more thorough step towards attacking a great subject affecting agricultural interests was taken in the engagement of Dr Lingard as Government Bacteriologist, and in his location at Pooná (*see* paragraph 272). This appointment had only been made shortly before I left India, but of the necessity of applying the latest advance of science to the investigation of cattle diseases there can be but little doubt.

In many enquiries of an agricultural nature, questions will arise
 Such, Reference
 quires, of

Mr W. J. Wilson, of the Public Works Department It would be well that the services of an agricultural engineer should be available, not only from time to time, but regularly, for the work of the Agricultural Department

436 The consideration of the various points raised in this chapter leads me, in concluding it, to make a few remarks on the general question of the appointment of scientific men to positions in India. There ought to be no reason why India should not possess her own staff of workers in various branches of science, instead of having so often to refer questions to home *experts*. There should be authorities on scientific subjects in India just as there are in England, in Germany, and in other countries. It cannot be said that encouragement is given to the pursuit of scientific investigation in India, and if the history of the many very able men, including even a Second Wrangler at Cambridge, who have gone out to India to fill appointments, be examined, it will be found that in but few cases have they advanced by the pursuit of the particular sciences of which they went out as exponents. The fault seems to lie in the fact that men skilled in a special science, and for that reason selected for India mostly find themselves, on arrival, drafted into the Educational Department, and forming part of a graded service. In this capacity they are obliged to move on through the different grades, taking up the respective duties of each of these, for, if they wish to keep to their own science, they must remain at the same salary as at the commencement. The outcome of this has been, that men who might have been original workers in science have had to abandon it for the duties of School Inspectors, or, despairing of further advancement in their own science have launched out into the pursuit of Meteorology and other subjects in which they might earn distinction. I have it from men in the Educational Department who had been originally chosen for their scientific knowledge, that, when once established in a position, they find their time so taken up with teaching subjects *other than* their own science, that they have to abandon entirely the hope of doing any original work, and have not even time to keep up their knowledge of what is being done at home and abroad in advancement of their particular science. The consequence is, that they fall behind, and cannot keep their

The position of scientific men in India

Want of original workers in science

437 The influence of science upon the development of agricultural knowledge has been very marked within the last half century. Inasmuch as chemistry is the branch of science most nearly related to agriculture, its study becomes of particular importance when the improvement of agriculture is concerned. The need of having an agricultural chemist in India has been recognised alike by the Government of India and by individuals of weight in that country. There is scope for the useful employment of an agricultural chemist in carrying out scientific investigation upon agricultural problems of the day, in planning and regulating agricultural enquiry and experiments and in examining and recording the results, in maintaining the continuity of experimental work, in acting as a 'referee' or "scientific adviser" to Government on all chemico-agricultural matters, in directing the teaching of agricultural chemistry, and in aiding the spread of agricultural education by assisting in the issue of agricultural text books.

A beginning should now be made by the appointment of an agricultural chemist to carry out the above duties. He should be a man with special acquaintance of the science and practice of agricultural chemistry, and should possess a good general knowledge of practical agriculture. The appointment of such a man should be regarded as experimental, and, accordingly, it would be sufficient to have only one man at first, who, while acting as 'scientific adviser' to Government, would, nevertheless, be equally available for all the Provinces of India. He must be given time and opportunities for making himself acquainted with the conditions of Indian Agriculture, and the first appointment should not be for less than seven years. His functions should be primarily those of an investigator and adviser, and not those of a teacher. He should be provided with a well equipped laboratory, and with an assistant chemist who shall be resident at the laboratory, do the necessary analytical work, and also teach Agricultural Chemistry. The most satisfactory plan would be to utilise the existing laboratories at Dehra and at Poona, each for six months in the year. It is not advisable that the 'scientific adviser,' or the assistant chemist, be allowed to engage in private work for individuals.

Further, it is very desirable that men of mark in other sciences, such as Botany, Entomology, Engineering, etc., should be attached to the Agricultural Department for purposes of enquiry and experiment

RECOMMENDATIONS.

RECOMMENDATIONS

438 That an Agricultural Chemist be appointed for India, to act as adviser to Government in chemico agricultural matters, to carry out investigation, and to direct Experimental Enquiry

That an Assistant Chemist be appointed, to act under the above officer, and to teach Agricultural Chemistry.

That to the Agricultural Department should be attached other scientific officers, such as a Botanist, an Entomologist, and an Agricultural Engineer, for the purposes of Agricultural Enquiry.

CHAPTER XVIII

CHAPTER XVIII.

EXPERIMENTAL

EXPERIMENTAL FARMS

The causes that have led to the establishment of special Experimental Farms

439. It may be said that wherever the work of agricultural improvement has been taken in hand, the establishment of an Experimental Farm has almost invariably been a part of the scheme. There are very good reasons, too, why this should be the case. Upon the carrying out of the ordinary operations of the farm at the most favorable moment depends the success of husbandry, and it has been found, over and over again, that this is hampered by the concurrent existence of work of an experimental nature, involving special care and expenditure of time. When a farmer's pocket is concerned it is hard to expect him to leave that upon which his living depends, and to attend to voluntary and unremunerative labour. When a wide stretch has to be sown at a favorable turn of the weather it is troublesome to have to delay to plan out an area, to measure out plots, to mark out paths, or to weigh out seed or manure, similarly, at harvest-time, when so much depends upon getting in a crop well, it seems to involve tedious delay in cutting and gathering plot by plot, in stacking and storing. Weighing, recording, and so it comes, for small areas, or for harvest operations, the experimental area is too often left to the last, and that which requires the most care is neglected, because there is not the time to give attention to it. The outcome of this has been that, even in England, the ordinary farmer will do little more than leave, perhaps, a bit of his field unmanured while the rest of it is manured, or he will put some particular dressing on one spot while the remainder is treated differently, and at harvest time he will merely judge by the eye what the result has been. But he will seldom go to the trouble of harvesting separately any definite area in order to learn precisely what its produce has been, as compared with another. Accordingly, the information thus gained is known to the individual only, and even this is of an indefinite and unrecorded nature. Experimental enquiry has thus been left to those whose opportunities or means have permitted their sacrificing a certain amount of time and money, or else to agricultural bodies or Government Departments. Even where private individuals of means have undertaken experiments, there has been felt the need of guidance and supervision, of accuracy and skill such as is not generally met with in the ordinary staff of a farm, and it is now fairly admitted that, unless an experiment can be separated from the ordinary farm work, and have a man of special ability set over it, and made responsible for watching it and for accurately carrying it out, it is almost vain to expect tangible results. This has led to the confinement of experiment mainly to

special places, such as Experimental Farms, or to the conduct of experiments under the guidance of men of scientific repute. This has been the case not in England alone, but in France, Germany, Italy, and other countries, so also in India. Indeed, the circumstances that have led to this result tell with more force in India than elsewhere, owing to the extreme subdivision of the land and the absence of a cultivating landowning class. Experiment has to be carried on, therefore, as something apart from the ordinary work of a farm, it must not be hampered by the latter, and has to be judged apart from the financial expenditure incurred.

In the present chapter I intend to review the past working of Experimental Farms, and to indicate in what ways improvement in the system may be effected.

440 That mistakes, and many mistakes, I might say, have been made, admits of no doubt, but that more mistakes have not been made, and that a far greater expenditure of money has not been incurred, appears to me to be still more a matter of wonder when it is considered what has been the agency at work in the past. With no scientific guidance, with no one skilled in agricultural experimental work, and with nothing but the direction of men having experience of English practical farming only, or of Civilians who have not even had this, I am only surprised that so much has been accomplished. Generally, let me say that, after what I had heard before coming out to India, and what I heard in India itself, I found Experimental Farms to be very much superior to what I had been led to believe I should find them. It has been my lot to inspect experiments in England with which many of those in India would compare very favourably. There have been, without doubt, a few men in India who have possessed a scientific spirit, and who have been actuated by a desire to work out agricultural improvement. The failing has been that the agency has been imperfect, and the continuity uncertain. Either the practical knowledge or also the scientific skill has been wanting, at all events, I do not know a case in which both have been combined in the one individual, or where there have been two individuals at work, one skilled in the one, the other in the other direction. In experimental

Past work of
Experimental
Farms in India.

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scientific skill
Experimental Farms
merical results

rather than of tangible conclusions, an indiscriminate mixture of good with bad towards the sorting out of which little or no real help has been given. It is not enough to state merely what has been done, and what results have been obtained, but the results require to be criticised, digested, and presented to the public in a form which can be understood at a glance. People not directly interested will not and should not be expected to wade through all the details of an experiment, to bear of this or that failure, but they do want to get at the gist of the whole, and to have it presented to them in an assimilable form. The conclusion I have

formed as to Experimental Farms is, that there has been a lot of good work done, but it is so hurried among what is not good as to be almost undistinguishable therefrom. A "sorting process" is what is required in order to make the results really useful. But that Experimental Farms have been useless and extravagant institutions I am very far from admitting, or that the men who have directed them have been incapable men generally, I would not for a moment allow. Where failure has followed it has been mainly because the conditions for success were not present. The faults are those which could be remedied by the employment of scientific and practical skill, and by having a continuous instead of a shifting agency.

The expenditure upon Experimental Farms

441 It cannot with justice be said, I think, that, on the whole, the expenditure upon Experimental Farms has been large. Here and there instances may be pointed out where excess of zeal has prompted excessive expense but the same might, with far more justice be said of other experiments of Government besides Experimental Farms. When, in April 1884 an enquiry was ordered into the conduct of agricultural experiments on Model Farms, the replies received did not indicate that there had been any serious waste of money, although it was allowed that if economy were called for it would be necessary to distinguish between what was purely of an experimental kind and what was rather of the nature of demonstration also that whereas the latter might reasonably be expected to pay expenses, the former must of necessity call for direct expenditure.

Distinction between Model Farms and Experimental Farms

442 My plan will now be firstly to indicate the general lines upon which Experimental Farms should be conducted, and, secondly, to illustrate the various points by reference to existing Experimental Farms in India.

I wish at the outset to clearly distinguish between Farms which exist for the purpose of demonstration and those which are intended for pure experiment. The former are intended to show to cultivators the result of a practice found by experiment to

be different from altogether. The object of these

nerative character. To make such a Farm a "paying" one is out of the question, though the experience gained from it may be highly remunerative in its subsequent application elsewhere. I intend to treat later on of Demonstration Farms, but to speak now of purely Experimental Farms.

Where Experimental Farms are needed.

443 *The Need of Experimental Stations or Farms*—That such are needed I have already sufficiently shown. I have enumerated the reasons which prevent private individuals from carrying out experiments, and I have in a previous chapter (see Chap. XVI, paragraph 406), mentioned several subjects which, for want of putting them to the test, still await decision. I may, therefore take the

general need is granted. It is, however, a different question *where* such Farms are needed. This has to be settled for each Province and for each district separately. To establish an Experimental Farm in a district, simply because, in the abstract, it is a good plan to have a place for trying experiments, is not a sufficient reason. The decision must be partly based upon considerations as to whether there are the means to support a Farm, and whether there be a suitable staff, but the main one should be whether there is any thing definite to learn, any particular question to solve, and whether this has any relation to the agriculture of the country around. Unless these questions can be answered in the affirmative, the need for an Experimental Farm has not been made out. A *prima facie* case must be established for the existence of such a Farm in any particular locality.

444 *The Supervision required*—Unless there be competent supervision there should be no Experimental Farm. This supervision should consist of, firstly, a Director, who may be the Director of the Provincial Department of Land, Records and Agriculture, or his Assistant Director where one exists, secondly a resident Farm Superintendent or Manager who shall see to the actual cultivation and to the carrying out of the details, thirdly, a scientific officer who shall be available for the purpose of advising and of assisting in the examination of the results obtained and also of ^{The necessary supervision}
 out any chemical analysis be the above, and, of an Experimental Farm should not be established

The Bengal Agricultural Department has attempted to carry on experiments by Assistants employed in the Department. These Assistants from time to time leave their office employments in order to visit the Experimental Station for the purpose of seeing how the work is going on. I found however, in one case, that the Farm had only been visited once in the course of the year. Such occasional supervision is of little practical value, especially when, as in the instance under notice, the resident manager was a man of very ordinary calibre, and had other estates to look after and other duties to perform. When however, as in the case of the Cawnpore Farm, and those at Nagpur and at Bhadgaon, the resident manager is a man of ability, an occasional visit from a responsible Director is all that may be wanted, but I am very decided upon the advantage of regular inspection and control by individuals directly responsible

445. *Situation of an Experimental Farm*—An Experimental Farm ought to be so situated as to be readily accessible to those who are likely to visit it. Thus, it should not be too far distant from an important centre, and yet it should be amid agricultural surroundings. If these *desiderata* be fulfilled, the Farm may be ^{The situation of a Farm.}
 and also be of importance or who may

In this respect with the exception of Bhadgaon and, possibly, Seebpore, existing Farms in India are well placed. Bhadgaon is, however,

too far away from a railway station, besides being a difficult place to get to, owing to rivers that have to be forded, Saidapet is too near the town of Madras, Seehpore also is perhaps too near Calcutta and too much surrounded with dwellings, besides not being in a sufficiently agricultural district

The kind of soil

446 *Soil suitable for an Experimental Farm* — Where the object is not merely to have a Farm for the conduct of scientific enquiry, but to do that which shall be for the benefit of the surrounding agriculture, the land chosen should be composed of soil which is fairly typical of that of the country around, so that the results may be applicable to as large an area of similar land as possible. If there be two or more main types of soil in a Province, this will constitute a reason for having more than one Farm in it, provided the requisite supervision be available. But to take up on the one hand, land which is naturally so rich as to call for no improvement or, on the other hand, land so poor or so sandy that no one would think of farming it if he could help it, is to render experiment profitless from the outset. The Saidapet Farm at Madras is, by the very nature of its soil, quite unsuited to be an Experimental Farm of benefit to the Presidency in general. It has a poor, hungry, sandy soil, and the land is little better than a great sandhill, in no way typical of any large extent of land throughout the Presidency. About other Farms I have no adverse remarks to make in this respect.

When a site, however, is to be chosen for purely scientific investigation, closer discrimination than is supplied by local considerations is required. Thus, if an experiment on the power of a certain manure be devised, the soil must be one that is neither too rich nor too poor. It must not be so rich that the influence of manures on it will not be marked, nor so poor that on this account it is not ordinarily culturable nor intrinsically worth improving. In brief, it must be a soil that responds fairly to the action of manure.

The size of an
Experimental
Farm

447. *Size of an Experimental Farm* — When an Agricultural Department or other agricultural body contemplates taking up an area of land for purposes of enquiry and experiment, the question as to the most suitable size of the area calls for careful consideration. This must be decided upon with regard to the exact purposes which the area is to serve, and the nature of the experimental work to be carried out. If experiment only is to be undertaken, and to be confined to such work as the growing of new crops and new varieties, or the effect of different manures on crops quite a limited area will do. A Farm of 20 to 30 acres would be quite sufficient in such cases, and even a smaller one might do. Similarly, for more strictly scientific investigation there would be no need to take up more than, say, 10 acres. In the experiments at Woburn, which I have under my care on behalf of the Royal Agricultural Society of England, the main experimental field is $7\frac{1}{2}$ acres in extent. Generally speaking, I would say that, for purely experimental work in crop growing or in manuring, 25 acres is a good size for a Farm, and it would be better to confine the area to this, and to limit the expenditure

similarly, rather than to take up a large farm with all the accompaniments of farm buildings, cattle, implements, etc. In short, I would not advocate taking up more land than was actually required for the contemplated experiments and for their probable extension. The larger an area is, the greater are the chances of variation in the soil, and these variations are likely to tell most injuriously when comparative experimental trials are being made, or when scientific investigation is concerned.

The objection urged against such small Farms is that they could not pay for the necessary superintendence, whilst larger ones might, and at the same time give the Superintendent enough to do. In such cases it would not be difficult to add to the purely experimental area a Demonstration Farm, or a seed growing Farm (*see later in this paragraph*). It may, however, happen that experimental work will be of a different and more extensive nature, such as the breeding of cattle, dairy farming, silage-making, or the cultivation of crops on a practical scale, according to different existing or newly introduced systems. In such cases an area of 25 acres would be manifestly insufficient, and the Farm would require buildings, cattle, pasturage perhaps, and it should also be able to supply the necessary crops for the maintenance of the stock, whilst, when comparative crop growing systems are tried, the difficulties attaching to the use of small plots may be sufficient to prevent their practical adaptation to the purposes of the enquiry. The farm, though really an Experimental Farm in design, becomes then one the greater part of which is cultivated in the ordinary way, and a portion of it only is kept as a purely experimental area. An extent of 100 acres, or even more, may thus be requisite, but I do not advocate more being taken up than is really necessary, and I do not favour the establishment of such large Farms as that at Bhadgaon (Bombay), which covers 1,200 acres. A great deal of time and labour must necessarily be involved in doing the ordinary farm work apart from what the experimental area specially requires, and the risk attending the gathering in of a crop at the proper time is too much, and the expenditure incurred too great, to prevent economical conditions from entering. It would be better not to hamper the Superintendent with more ordinary farm work than he can see to without neglecting to give due care to the experiments, and it would be wise to set apart a certain sum yearly for the purpose of experimental enquiry, and to consider it as an expense, rather than to expect a Farm Superintendent to make his farm pay by virtue of the superior cultivation of a large area exceeding the extra cost involved in conducting experiments over a portion of it. The farm at Woburn, which, by the Duke of Bedford's liberality, has been placed at the disposal of the Royal Agricultural Society of England, is 180 acres in extent, and of this about one half is utilised for experimental crop-growing and for feeding experiments, the rest being in pasture, or else used for growing ordinary farm crops. The experiments, however, in every case occupy the first place, and everything else has to be subordinated to them. Feeding experiments on cattle and sheep

are conducted every winter season exhaustive enquiries on ensilage have been made, and yet ample room has been found on the area of 130 acres for all purposes of experiment. I have, therefore, every reason for urging that farms for similar purposes in India should not be hampered by the occupancy of a large area, and also for saying that 100 acres or a little more will be found ample for all practical requirements.

It may sometimes be thought desirable, in addition to a purely experimental area, to have a "demonstration farm" or "model farm" attached, where may be shown, on a practical farming scale, the results of what has been found successful upon the Experimental Farm. In that case the area to be taken up may well extend to, say, 50 acres. Or, with the Experimental Farm it may be desirable to include a seed growing farm, whereon seed for distribution to cultivators may be raised. This has been done at Cawnpore, the experimental area covering 42 acres, and the seed growing part another 12 acres, besides which an additional 50 acres is used as a fruit and vegetable garden. The combination of two such objects is, I think, very desirable for Agricultural Departments to carry out, but I would like the two to be, as at Cawnpore, quite distinct. It is impossible to state what area could be usefully employed, but, speaking broadly, 50 acres should be about sufficient in most cases at beginning, leaving it to be extended should occasion arise.

The size of an
experimental
field

448 Size of an Experimental Field—The size of a field should depend much upon the suitability of the situation and the nature of the soil. Thus if 10 acres of land were required, it would be better to have two level areas of five acres each, than to have a consecutive stretch of 10 acres on land of uneven character. Similarly, if the soil varied greatly in character, or if on the same area were parts typical of two different classes of soil, two blocks in different parts would afford more information than a single one.

Conditions of
experimental
field

449 Conditions relating to an Experimental Field—The experimental field itself must be as level and uniform in character as possible, one part must not be on high ground, another on low ground otherwise water may lodge on the lower level, or the surface soil from the upper may be washed down to the lower level, the soil must not be deep in one place and shallow in another, but fairly uniform throughout, similarly, the soil must be of the same quality, as nearly as can be judged, all over the area, trial diggings should be taken over the field, in order to see that there are not great apparent divergencies in these respects, the plots themselves should be removed from the influence of trees, hedges, or shades, which may affect them unequally or adversely. The previous history
If possible, in order

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the whole of the field and in a practical way whether the field be uniform or not. If wide discrepancies appear, then it is quite sufficient evidence that some part or else the whole of the field is unsuitable for experimental purposes. I am quite certain that many of the seemingly contradictory and peculiar results obtained at Experimental Farms arise from neglect of a precaution of this kind and that time, labour, and expense might be saved in the end by the sacrifice of one year at the commencement, in order to ensure that the area chosen be a suitable one in the matter of being equal in crop-producing power.

450. Plan of Experiment.—A suitable site, an uniform field, and efficient supervision being provided, the plan of experiment may next be drawn up. It is greatly from want of having a definite plan and a definite object in view that experimental work in India has failed. In the majority of cases (and I would mention the Dumraon and Seebpore Farms as examples, though the same might be said more or less truly of the others also) the leading idea, when an area has been found available, has been to cover it with as many experiments as it will hold, regardless of the possible developments that may take place after the experiment has once been started. This position, I know, has, to a great measure, been forced upon those who are in charge of such Farms, and they have been expected to evolve as many results as possible in the shortest time, and the abundance of experiments in progress has been the criterion of activity rather than the intrinsic worth and accurate carrying out of those that have been undertaken. There is a common impression that an experiment can be carried out upon the first subject which suggests itself, and that the more varied the forms be in which it is presented, and the more numerous the plots which compose it, the more valuable and exhaustive the enquiry must be. This may be, and generally is, an entire mistake.

451. The first definite object they may best conduct have that Two main divisions of experimental enquiry.

Now, experimental enquiry may be of two kinds.

Firstly, it may be more specially scientific in character, such as the finding out of fresh scientific truths or the testing of scientific theories. These experiments can only be carried out under the immediate supervision and care of a man of scientific attainments, such as the "scientific adviser" spoken of in the last chapter. The arrangement of them and the entire control must be left absolutely to him, and they cannot be made distinctly popular, or be always set out in such a way as to clearly demonstrate to everyone the line of enquiry pursued. Briefly, they need such explanation for their right understanding as only a specialist can give. The area occupied by investigations of this kind will, however, be but Scientific investigation.

a limited one, and they may frequently be even of a laboratory character. Of this nature are, for example, experiments on the nutrition of plants, the assimilation of different soil constituents or of atmospheric gases by plants, the exhaustion produced by continuous cropping, or the effect of different fertilising salts.

These find their

scientific expression

and Dr Gilbert and to a lesser extent in those at Woburn

John Lawes

Practical
experiment.

Secondly, experiment may be of a more practical kind, such as the testing of the value of different processes already in use, the economical effect of various manurial ingredients upon particular crops, the collection of information regarding the outturn of crops, the growth of new crops and new varieties, the trial of new implements. For these considerably larger areas will be required than for the more scientific investigations.

Experiments
must have a
bearing upon
actual
agricultural
practice

452 Whichever be the kind of experiment, in each alike a definite plan must be set forth. For the existence of this, in scientific investigation, the expert himself may be trusted and it may not be possible, as noted previously, to indicate this to the comprehension of everyone. But in the practical experiments the object and the plan should both be set out clearly and unmistakably. I may be allowed here to give a few hints illustrating them by what I noticed at Experimental Farms in India. The first requirement is, that every experiment should have a distinctly practical bearing, in other words, it should consist of the trial of something which, should success in the experimental stage attend it, will be capable of practical application to the farming of the country, and effect an improvement in it. There must be some *prima facie* ground for believing that what is tried by the experimenter may be carried out by the cultivating *raiyat*. Thus, a manure might be tried which the *raiyat* is not able to get, either because it is beyond his power to purchase, or because it is not obtainable in sufficient quantity, an implement might be experimented upon, which would always be beyond the *raiyat's* purchasing power, a crop might be grown which would be of no use to him, or which his prejudice would prevent him from touching. In all such cases the experiment could do but a limited good, and often no good at all. Yet this kind of experiment has been carried out again and again on Government Farms, and the fact accounts, in no small measure, for a good deal of the odium which Experimental Farms have incurred in the past.

Manures
employed should
be those in
common use

At the Cawnpore Farm I found that the best result in wheat-growing, and also in potato-culture, had been derived from the use of wool waste. But, on enquiring where it could be obtained, I heard that it came from a manufactory near by, and that the Farm took the whole of the waste. There are but few such factories in India, and the amount of wool waste produced is insignificant. What good can it do the *raiyat*, therefore, to know that, in order to get the best crop, he must use what is not even an obtainable article? In another experiment I found that muriate (chloride) of ammonia was used, a material far beyond the power of the *raiyat*

to get, whatever might be the benefit to be derived from it; besides this, the muriate is one of the dearest forms in which ammonia can be purchased. Also, I saw plots on which the refuse water from indigo manufacture, called *seel* water (see paragraph 348) was used. But it is only here and there that *seel* water can be procured. Again, for an experiment to have been properly conducted, the plot for comparison with the one treated with *seel* water should have had supplied to it a corresponding volume of ordinary water in order to make the trial a fair one, but I could not gather that this had been done. The manures to be tried on Experimental Farms should be those which are within the power of the *rasyat* to obtain, and which are in general use throughout the country, or else those of which there is some likelihood that use will be made in the future. Expensive chemical manures imported from England can at present have no place in the *rasyat*'s farming system, and, therefore, they should not be included in practical experiments. I found

that Government, the Government of Madras Reports speak of manures which cost some beyond the reach of cultivators, and it should be only under very special circumstances, such as the preferment of a request from Government that they should be tried, which should induce their purchase for any Experimental Farm. It may be desirable, perhaps, to know whether a threshing machine would pay to use in the event of wheat being sold in bulk or of its being required clean, or else when coming off large Estates. But these are exceptional cases, and should not form a part of the ordinary duties of an Experimental Farm, the primary object at which is to attempt what may improve the

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453. Experiments should be as simple as possible, they should be self-evident, and ought only to need the minimum of explanation. The issues of an experiment should be simple.

are taken up in its demonstration. There should be clear and definite issues involved, and one only rather than a number. Each

In manurial
experiments the
principle should
be aimed at

454. When manurial experiments are tried, it is not enough to mark out a number of plots upon which the same crop is grown and to apply the manures indiscriminately, without relation to one another, the soil or the crop. Something more ought to be sought for than to know that this particular manure is better than that one, the *principles* of manuring ought to be aimed at, and the endeavour should be made to find out why it is, or what it is in one that makes it superior to another. The principle being involved, the application of it to other materials embodying that principle, or to altogether new ones, may constitute a further, and possibly

Comparisons
should be made
on a clear basis.

the principles in accordance with which they and others like them may prove useful. Comparisons should be made upon some clear basis, thus, farmyard manure, green manuring, and night-soil have a certain affinity, in that they all are what one may term "organic manures", but bones and nitrate of soda have no affinity, nor yet has lime to either of the others. It may be well to try whether phosphatic manures or soluble nitrogenous salts are required for a crop, and then bones might be tried against nitrate of soda, but bones would be hardly sufficient in themselves to test the question, and other forms of phosphatic manures should be tried as well. A further question may arise, *viz.*, in what form is phosphoric acid best applied, or in what form should nitrogen be used? Each of these calls for an experiment by itself, which, when solved, may be turned to the elucidation of the original enquiry.

An area once
manured is for a
time afterwards
rendered useless

455 The setting-out of the plan of an experiment, therefore, is not such a simple matter, and needs more knowledge and experience than the amateur agriculturist is able to command. Nor must it be forgotten that when an area is once covered by a manurial experiment it is most certainly spoiled for future experiments for some little time to come, inasmuch as the manures are not dissipated at once, but their effect will, as a rule, be seen on subsequent crops as well. I have constantly found this principle ignored, and experiments have been started afresh on ground which has been variously manured during the progress of a previous trial. The essence of a comparative experiment is, that all the plots should start fair and level. Yet I find that at the Nagpur Farm a complete manurial series was conducted for several years in succession with manures thoroughly divergent in character, such as saltpetre, bone-dust, cattle-dung, green-manuring, etc., and then the series was exactly reversed, and manures were put on where others, quite different in nature, had been previously applied, the land meantime having had no opportunity of resuming its equality of producing power. Satisfactory results in such a case could not be expected.

Previous
treatment and

456 At the Poona Farm an experiment was being tried with *jauar* (millet), but over one-half of the area sugar-cane had been the

crop, and over the other half, gram (a pulse). Such previous uneven treatment of the land is quite enough to interfere with the success of an experiment. Manures should be chosen with reference to the soil and the crops, and, in drawing conclusions, it should be borne in mind what the conditions are. Thus, a soil rich in vegetable matter would not be the one on which organic

relation to soil and crop should be considered

must not be laid down without reference to the particular conditions that prevail at any one spot.

457. I am in favour of having what I saw at the Experimental Farms at Cawnpore and at Nagpur, *viz.*, a continuous series of manurial experiments on some one or more staple crops, such as wheat, cotton, sugar-cane, etc., the same crop being grown and the same manures being put on year after year. It may be said that this would not occur in practice, as a rule, but it is the way in which the best information is brought out as to the requirements of the particular crop, and also as to the effect of the different manures used; the varying influence of seasons is eliminated, and

The advantage of a continuous manurial series with one crop

cars. way
Agricultural Association. Mr. Ozanne had, at the beginning, laid out the line of experiment, intending the Association to try it upon the general rotation adopted in the district, but, the crops having been once sown and the manuring put on, both were continued year after year afresh, just because the 'Director said so' had started it in this way. On coming there again, some years later, Mr. Ozanne found the appearance of the field just as he had left it.

458. Occasionally, feeding experiments have been undertaken. For example, at Saidapet Farm (Madras) I saw a pen of four sheep being fed on earth-nut cake with other foods, and four without any cake. Again, at Poona it has been attempted to gauge the relative milk-yielding qualities of cows of different breeds by taking single specimens of each. To anyone who has had experience of experiments with cattle or sheep it will be readily apparent that to attempt to draw conclusions from four sheep or from a single cow is almost worse than useless, in fact it may often be totally misleading. The "personal equation" with farm animals is so great that, unless a sufficient number be experimented on, no proper conclusions can be drawn. Animals forming a part of an experiment must be of the same breed, the same age, and the same upbringing, as nearly as possible. In the Wohurn sheep experiments the number of sheep forming each pen is from 20 to 30, and I should not like to take a smaller number. When cows are concerned, there come in further considerations as to the date of calving, the time of year, and other fluctuating circumstances which render absolute experiments with milking-cows a very

Feeding experiments.

difficult and intricate matter. In the Rothamsted experiments on the value of silage as against roots for milking-cows, Sir John Lawes and Dr Gilbert were not satisfied with less than 30 cows in each set. Of course these last experiments were for absolute accuracy, and I would not say that useful general information could not be obtained with a considerably smaller number of animals, yet it is quite hopeless to attempt it with half a-dozen sheep, or with two or three cows.

Illustrations of experiments to be tried

459. I am strongly in favour, therefore, of having practical experiments in India of as simple a nature as possible, and involving only clear issues. There are many experiments which are of this nature, and a plot cultivated or manured in one way placed side by side with another cultivated or manured differently may afford more information than any elaborate series offering several and often confused issues. The greatest good will, I believe, result from exhibiting side by side some native practice and another by which it is proposed to replace it. Of this kind are the following: deep ploughing *versus* shallow ploughing, thin seeding *versus* thick seeding, different depths of putting in the seed, different times of planting, different modes of cultivation, irrigation by means of heavy or light waterings, green-manuring with various kinds of crops, and so on.

Native and introduced implements must be placed side by side

Similarly, in the case of trials of implements. It is not enough to exhibit a new implement and to show what it can do by itself. It needs to be put side by side with a native one, and, indeed, the cultivator, before he is persuaded of its value, must work the two himself side by side on his own holding, otherwise he will go away from the Experimental Farm or the Agricultural Show and content himself with merely saying what a good implement the new one is, but without the least intention of replacing his own by it.

The advantage of simultaneous experiment in different parts

460. One great advantage of having all experimental work under the general survey of a "scientific adviser" is that, by this means the same experiment may be concurrently tried over different parts of India. In this way general truths may be obtained for the whole country instead of for one particular spot only. A uniform result would be of far more lasting and wide-reaching benefit than more numerous ones which might be the outcome of the peculiar circumstances of special districts. I would much rather see a joint conclusion of this kind arrived at as the result of experimental work on Farms than the many and often conflicting conclusions which are now drawn.

The size of experimental plots

461. A few words may be said in regard to the plots themselves and their arrangement in an experiment. First, as to their size. In this respect I have not much fault to find with what I saw in India. As a general rule, I might put it that the maximum size of a plot should be one acre, the minimum size one-tenth of an acre. For merely trying new crops or new varieties of crops, considerably smaller plots might be used, but where there is anything of a strictly comparative nature to be tested, I do not think that it is

th roughly suffices to take less than one tenth of an acre. I am well aware that much has been said as to the convenience of quite small plots, and of "pot culture" as against field trials, but "pot culture" requires far more constant and careful watching than field plots, and small plots are liable to many more extraneous and accidental disturbances than larger ones. The multiplication of the crop of a small plot to the acreage return means also the multiplication over and over of every slight error and it may become a big one when taken on the acre. On a small plot, I contend, the crops are not a fair index of the acreage yield for along the edges of a plot it will always stand higher than elsewhere, having a wider area from which to draw nourishment, on the other hand, injury to a single plant either by insect or vermin pest or by disease will affect the produce of a small plot, whereas on a good-sized one this will be immaterial. I well remember being taken over an Experimental Station in England which was conducted by a strong advocate of the system of small plots. Noticing a luxuriant deep green spot on a patch of wheat which was meant to exhibit the effect of withholding nitrogen from it I inquired how this green spot came, and I was told that the horse used in the ploughing had, unluckily, chosen this particular spot for halting a moment and letting some highly nitrogenous manure fall upon the plot. The plot was only one thousandth of an acre in extent, and it is not likely that the horse would have stopped similarly one thousand times while ploughing the entire acre, nor would a hare or rabbit, perhaps, nibble off from an acre just one thousand times as much as it had done from a small plot. Besides this although small plots and "pot culture" may serve useful purposes in careful hands, I do not consider the results to be more than indications of what is likely to occur on the large scale, and, until confirmed by field experience under the natural conditions which present themselves in practical agriculture, they do not carry conviction with them. It is not possible in "pot culture" to imitate the natural conditions, nor the influences of temperature, atmosphere, water, and soil which are at work in the open field.

462 The system of having duplicate plots in an experiment is a very wise one. By this means an anomalous result may often be checked, and a satisfactory one be confirmed beyond doubt. The provision of duplicate *unmanured* plots is even more important, for, by having these, one in one part of the experimental area, and one in another part, it is at once established whether the two unmanured plots substantially agree, in other words, whether the field is of even producing capacity, and in this respect, suitable for experiment. A great deal of trouble, and also money, could, I am sure, be saved in experimental work and far more satisfactory and conclusive, though less comprehensive, results be arrived at, were this system of duplicate plots, more especially of unmanured or "standard of reference" plots, more extensively used.

Duplicate of experimental plots

Space to be left
for extension of
experiments

463 Next, it is a wise provision not to take up, at the outset the *whole* of the space allotted to an experiment. As the trial proceeds fresh issues may present themselves which may render it desirable to add other plots to the series, or one part of the area may not be as uniform as another, and repetition of a part of the scheme may be desirable. Space for extension of the experiment in the future should, accordingly, be reserved.

The separation
of experimental
plots

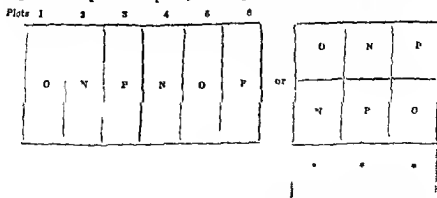
464 Further, it is a good plan to have the experimental plots carefully marked out by pegs, and divided by small paths from one another, while the area covered by one experiment should be separated by a broader interval from an adjoining one. This provides for the better supervision and observation of the crop, and, by adopting it, differences and inequalities can more easily be noticed.

A specimen plan
of experiment.

465 I might here set out a simple plan of experiment which is capable of further extension if needed, but which, even as it stands, is quite comprehensive enough to yield useful results if properly carried out.

Suppose the plots marked V to be those on which an existing *native* system of cultivation or ordinary method of manuring is carried out, and the plots marked P to be those on which a *proposed* new system is to be tried while those marked O represent the unmanured plots or *blank* plots which test the soil's natural produce.

We might have the following arrangements of the area, according to the space at disposal, or the position of the field —



O Blank experiment or unmanured plot
N Native system or present manuring
P Proposed system or proposed manuring

* Space for possible extension of experiment

In either of these arrangements the carrying out of experiment *in duplicate* would ensure greater accuracy.

As actual
experiment and
the plans on
of its objects

466 To give an instance of what I should consider a good experiment on the manurial treatment of a crop, I quote the following

from one of the Field Experiments of the Bath and West of England Agricultural Society, conducted in 1849 upon the barley crop.

A	T	C	D	E	F
11 bush Nitrate of Soda, 2 bush of neutral sulphate of ammonia, 2 bush of muriate of Potash.	11 bush of Ammonia, 2 bush of neutral sulphate of ammonia, 2 bush of Muriate of Potash.	No Manure.	11 bush Nitrate of Soda, 2 bush of neutral sulphate of ammonia, 2 bush of common salt.	11 bush of Ammonia, 2 bush of neutral sulphate of ammonia, 2 bush of common salt.	No Manure.

Kilograms per acre

Upon examining the above scheme it will be seen that each plot is set to answer some definite question, thus:—

1. The duplicate unmanured plots C and F give the natural unmanured produce of the soil, they tell whether the two parts of the field are of equal fertility and hence whether the area is a suitable one for experimenting on. Also, they give the basis for telling to what extent any of the manurial applications have been of benefit.
2. The plots A and B tell whether nitrogen in the form of nitrate of soda, or of its equivalent in sulphate of ammonia, is the better, as the other manures comprising the mixture remain the same in each case, any difference would be traceable to one or other of the nitrogen-containing manures.
3. The plots A and E, being alike in all respects except in the presence of potash salts in plot A, answer the question as to whether the addition of potash is beneficial or not.
4. The plots D and E, being alike in all respects except in the presence of common salt in plot D, enable one to tell whether it is advisable to add salt to the manurial mixture.
5. The plots A and D answer the question as to whether the dearer muriate of potash is better than the cheaper muriate of soda (common salt).

The above experiment was conducted on a field of 10 acres, with comparative particular point, it was tried simultaneously on different parts of England, and on land where in each case the same crop (wheat) had preceded the barley. Hence the results acquired special importance, and the experiment was an eminently satisfactory one.

This concludes the consideration of the *Plan of Experiment* (commenced in paragraph 450).

Recording of
details

467. Recording of details.—During the progress of an experiment, details of what takes place, either in the ordinary course of cultivation, or else abnormally, should be recorded. Thus, there should be notes made of the time at which the different field operations are carried out, the preparation of the land, the time of manuring, of sowing, of watering, of ripening, and of harvest and threshing, also, special occurrences, such as those of heavy rainfall, continued drought, frost, blight, failure of plant, injury to plot, or other unusual feature, should be recorded. These need not be made use of in a Report, else it may be overburdened with details, but they will certainly be very useful when the results obtained are compared, and will aid in explaining the anomalies which so frequently present themselves in an experiment. It may, for instance, be established in this way that one part of an experimental plot is always of higher natural productive power than another, or that one part, by its situation or exposure, is more liable to damage of crop than another, all such irregularities should be taken into account, and they can only be found out by continuous watching of the experiment during its progress.

The cost of
cultivation

In the generality of experiments which would be carried on at Farms in India it is desirable that, so far as is possible, a comparative record of cost of cultivation should be preserved, and also that, where manual experiments are tried, the cost of the different manures and their application should be noted and clearly indicated. It is well that each plot of an experiment should be distinctly labelled, the label bearing a concise description, both in English and in the vernacular, of the treatment of the plot and the experiment of which it forms a part. This should contain a statement of the cost of the manure, when any has been applied. The importance of being able to see at a glance what is intended to be conveyed by an experiment is obvious. In more distinctly scientific experiments the factor of cost does not enter, as the object is to test a theory or ascertain a truth, whatever the cost and trouble involved may be. But in experiments that are to bear directly upon actual practice the question of relative cost must not be excluded, and it becomes in the end the standard of appeal by which success is to be gauged. At the same time, the very circumstances of an Experimental Farm, the necessity of using hired labour, the extra cost of superintendence, the smallness of the plots, the additional expenses involved in separate cultivation, prevent the statements of cost being in character, and they do not represent actual costs.

Statement of
results

468. Recording of results.—The recording of results should be, as far as possible, upon one uniform plan. On looking over the Reports of Experimental Farms I find that in the statement of harvest returns the results are sometimes given in terms of increase or decrease per plot, as compared with the standard, or unmanured, produce sometimes in reference to difference per acre, and sometimes in terms of "percentage of difference." It would be much better if an uniform system were maintained throughout. When

the Report is written in English, the most convenient standard of reference is the acre, and the weights should be taken in tons, cwt., qrs and lbs or else in bushels. There is no need to overburden a Report by stating the produce "per plot." What a particular plot produces is of no interest; it all depends upon what the size of the plot may happen to be. If, however, the Reports be written in the vernacular, it is difficult to say which is the best plan to adopt, whether the local land measure and local weights, or whether "standard" ones, should be taken. The different values attached to the *bigla* (land measure) and the *maund* (weight standard) in the various Provinces make the interpretation of results difficult. The Imperial *maund* of 52½ lbs. and the English *acre* would probably be the best understood "standard." The most natural plan at first sight would seem to be to use the local equivalents, but, seeing that the experiments are intended also for comparison with other parts, the best way would be to adopt, both in the English and the vernacular Reports, a double system of classification, the one local, the other general, and to put them side by side, with the necessary explanatory remarks as to the terms used.

In every case I think that increase or decrease should be stated in terms of "increase over standard plot," or "increase over unmanured plot," calculated upon (a) the acre, (b) the local *bigla*.

In some Reports I have noticed that the attempt has been made to translate the results obtained into a money figure. It may be naturally argued that, since the *money* gain is the final test, an experiment ought to show what this is. The same feeling has been expressed with regard to English experiments, but I may say that I have always upheld the system which I consider much better, *viz.*, to state the *actual results* obtained, and to leave people to apply them to their individual and varying circumstances. This has now, so far as England is concerned, been recognised as the best plan to follow, and I certainly advocate it for Experimental

Not desirable to give results in money equivalents

items of produce are, however, upon the particular conditions are made, and these conditions. Thus, what may be profitable under one set of circumstances may be converted into a loss under different surroundings, and so, while no one can dispute the actual weights obtained, the translation of them into money figures may involve erroneous assumptions, or,

selling price in the market or the price of it consumed on the farm; market for a certain article e in another, straw or green bly profitable to sell, while, at a distance from a town they may have only their consuming

values It is decidedly better, therefore, to state the results of
 leave each person
 slate them into
 district.

Examination and
 publication of
 results

469. *Examination and Publication of Results*—The absence of a careful and critical examination of the results obtained has been one of the worst features of experimental work in India, and it is largely owing to this fact that it is so difficult when taking up any Farm Report, to do what may be called "make head or tail out of it." Something more is needed than merely to put down the results obtained, and to leave them in a tangled, unassorted, and often self contradictory form. Each result should be studied by itself first, and then in the light of other results, and it should only be allowed to be put on record after it has stood the test of
 fully said, that fail-
 d that there is often
 fully agree, and I

think it is quite right that failures should be recorded, and the reasons, if known, should be set out. But, when an experiment is thoroughly had in design, or when it has been damaged during progress, or when results obtained are evidently unsatisfactory or contradictory, I cannot see the force of putting on the experiment in detail, and of trying to draw conclusions from it, still less of burdening a Report with it, and of burying a good experiment amidst the records of bad ones. If desired, these may be put in a separate section, but the main Report should, I think, consist purely of the record of those experiments which have passed a critical examination, and which constitute a distinct advance in agricultural knowledge. The examination of the results, it is clear demands the employment of someone particularly qualified for the work.
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 consider, c
 obtained at any Experimental Farm they should be sent to the "scientific adviser" for his perusal and examination, and it should be for him to say which experiments are good and satisfactory, and

Advantages of
 having a
 sole office
 advise to
 examine results

Provincial Governments to print what they liked. At the same time, however, as the Imperial Government would, in all probability, issue a record of experimental work for the whole of India, it is only reasonable to suppose that they would only take cognisance of what the "scientific adviser" deemed worthy of publication. The issue of a general Report of this kind, not for one Province alone, but to combine the results of work in the several Provinces, would be very useful.

It may be allowed to give from my own experience, an instance of the useful supervision which such a "scientific adviser" could

exercise in the elimination of bad or imperfect results from good ones. When asked to go over the Report of one of the Experimental Farms in India (the Farm being, I might add, certainly one of the best), I found drawn up at the end of the Report the results obtained for each experiment carried out. This had been done in the form recommended, after general conference with Agricultural Directors, by the Revenue and Agricultural Department in their Circular No. 143 A, 25th December 1895. In the column entitled "Comparative Record of Experiments" were given no less than 35 different results for this one Farm. After going carefully over these, and after eliminating the ones which I considered unsatisfactory, the number of results was reduced to 11, and these 11 results were all that I should have advised being placed on record. It would be far better to have, and far easier to follow, 11 good results that would bear criticism, than 35 results, many of which would not

470. *Dissemination of Results.*—Upon the wide dissemination, in a clear and intelligible form, of the results of experiment depends much of their value and also popularity. There should not be too many Reports, and I should say that an annual one for each Farm or set of Farms is all that is needed. There is no call to have a Report for each season's crops. Dissemination of results

It is not possible to preserve complete uniformity in the returns, nor to lay down any precise plan for setting out the results. One experiment may require to be stated in one way, another in a different way. The most that can be done is to make these as alike as circumstances will permit, and to have one system of units adopted in one column at least, of the returns, so that they may be comparable at a glance, and not have to be calculated on to a common basis. Thus, to give results in one case in weight per acre, in another in weight per local *bigha*, at one time in *maunds* of 80 lbs., and so another in *maunds* of 40 lbs. (as in Gujarát (Bombay)), or in *maunds* of 28 lbs. (as in Coorg), is sure to cause confusion, and, therefore, the adoption in one column of a statement in terms of acres, and of tons cwt. qrs lbs., or else of bushels, is necessary. This should be done in the English Report.

But I think it is very desirable that the Reports, or at least an abridged version of them, should be published in the vernacular also, and be disseminated in this form. It is mainly by such means that the work done at Experimental Farms can be po- Reports in the vernacular also

This leads me to observe that it would be a good plan to organise periodical visits to Experimental Farms, when, under the guidance of the Superintendent or Manager, visitors might be taken round to study the experiments, and any necessary explanations might be given on the spot. Periodical visits to Experimental Farms

The publication and dissemination of the results of experiments should be undertaken by Government, and not be a direct charge upon the Farms.

The necessity
of time and
patience in
experimental
work

471 *Need of Time and Patience*—If, in any agricultural work, time and patience are required, it is in that of experimental enquiry. A result is really not a good one until it has been repeated, and sometimes often repeated, with the same result. It is only by repetition that errors can be avoided, and accidental circumstances be eliminated. A difference of season may easily cause a difference of crop, or even of result, but by repeating the experiment the varying influence of season will be checked. I regard it as far more useful to get one sound result, the outcome of trial in different years, and under varied conditions, than to get fifty or even a hundred results which subsequent experiment might disprove. I sincerely trust that, if a fresh impetus be given to experimental work by its re-establishment under a system such as I have proposed, Provincial and Imperial Departments of Agriculture will recognise that time and patience must be given, and that they should be content to wait for solid results, rather than that they should press those in charge to give returns which, unsupported, have but little value.

The financial
test is not to be
applied to
experimental
farms.

472 *Financial Test not criterion of success*—I have already drawn (see paragraph 442) a clear distinction between Farms for *experimental* and those for *demonstration* purposes, and in the foregoing paragraphs I have mentioned, in passing, several circumstances which constitute differences between farms under ordinary cultivation and those devoted purely to experiment. The financial result of the working of an Experimental Farm should not be taken as the criterion of its success. As I pointed out, when different systems are put to a test, there may be many which prove unsuccessful, and perhaps only one a success, or else all alike may be found to be ~~it~~ ^{money} thrown away, ^{in this way,} and it ^{pense} ^{to the} future. But there are other matters, special to an Experimental Farm, which involve expenditure not ordinarily incurred. When areas are small, as experimental plots generally are, and when these are marked out and separated from one another by paths, etc., their cultivation is of necessity much more expensive, and the ground is not so fully covered as if a whole stretch were cultivated alike. The application of manures, or of watering, is more difficult, and involves more care and time, when harvest comes, crops have to be kept separate on the different plots, and to be reaped, threshed, and weighed separately. The entire economy of labour on the large scale is lost thereby. But it is in the matter of the employment of labour that a heavy burden rests upon Experimental Farms, and one which constitutes a great difference between the conditions of the Farm and those of the *rayat's* small holding. The *rayat* employs on his holding his own labour and that of his family, rarely using any hired labour, but on an Experimental Farm all must be hired labour,

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and it is often very hard to procure this, nor is the labour always of the best, for a man does not work with the zeal that attaches to his own cultivation.

I have looked into the expenditure of Experimental Farms in India, and although there have been instances, especially in the case of Saidpet (Madras), of excessive expense incurred, I cannot say that I think that, on the whole, unreasonable sums have been spent on these farms. The Bhadgaon (Bombay) Farm, comprising 1,200 acres, cost over and above receipts, in 1858, Rs. 980 only, and in 1859, Rs. 745 only, exclusive of the superintendent's salary of Rs. 3,000; the out-of-pocket expenditure on the Nagpur (Central Provinces) Farm of 90 acres was, in 1858-59, Rs. 3,744. These amounts do not read as large ones when compared with the 600*l* to 700*l*, a year which the Duke of Bedford gives for the support of the Woburn Experimental Farm of the Royal Agricultural Society of England, or the very much larger sum (probably about 3,000*l*) annually expended by Sir John Lubbock upon the world-known Rothamsted experiments. In the United States of America there are 54 Experimental Stations, all of which are subsidised by the State, a sum of 3,000*l* a year being paid to each.

473 Suitability of present Experiments—I have no fault to find, on a rule, with the kind of experiments which have been conducted on Experimental Farms, and I would not suggest, therefore, any divergence from, or great extension of, what has been the aim in the past, for the general aim appears to me to have been good. What I do find fault with is, the way of carrying the experiments out; that is, I blame the plan rather than the object. Experiments on the manuring of particular crops may be perfectly good ones if the manures used are such as are readily procurable, but if they are expensive chemical manures the object may be deprived of any practical outcome by the plan being laid. The comparative produce of a crop under different systems of cultivation, different methods and times of sowing, different depths of ploughing, varying amounts of watering, etc., may form a fitting subject of enquiry, so, also, may the influence of the selection of seed and of change of seed, the out-turn of crops, the growing of new crops and new varieties of crops, the trial of new implements, etc. The general line that experimental enquiry should take is to exhibit side by side a local practice or native system, be it of cultivation or of mechanical device, and another practised elsewhere in India or introduced from abroad, and then to see which one is the most successful in its results.

Then there are more extended but very necessary enquiries, such, for example, as that which Mr. Ozanne originated at Bhadgaon, on the feasibility and cost of establishing "Fuel Reserves," and, again, the more extensive one of the breeding of cattle.

474 Seed-growing and Cattle-breeding at Farms—But there is still another purpose which Experimental Farms, in the broad sense, can usefully fulfil, viz., that of becoming centres for the growth and distribution of pure and selected seeds, and for the

The kind of
experiments
on land in
Experimental
Farms

Farms as seed
distributing
centres and
cattle breeding
farms

location of stud bulls, as well as, in some cases, for the breeding of cattle, and the distribution of bulls to the districts around. Objects of this kind would have to be carried out on an area apart from the more specially experimental one, but they might very well, where opportunity serves, form adjuncts to an Experimental Farm, and could be worked concurrently with the latter under the one supervision. This is actually done, so far as seed growing is concerned, at the Cawnpore Farm, whilst, at Bhadgaon, cattle-rearing is an important part of the work of the Farm. Reference to these has already been made in Chapter XIII, paragraph 310, and in Chapter XI, paragraph 257. At Cawnpore a separate area of 12 acres, attached to the Experimental Farm, is utilised for growing cereals for sale as seed, and another area of over 50 acres is kept as a fruit and vegetable garden.

It is certainly one of the most useful functions that a Government Farm can serve, to act as a seed-distributing centre, and where conditions are favourable, as a cattle-breeding farm also, and both these objects might often be carried on concurrently with the more special work of experiment.

Demonstration on
Farms

475. Demonstration Farms—There are other Farms which, though not experimental in character, are so closely allied to Experimental Farms as to call most suitably for treatment here. These are the "Demonstration Farms," to which reference has already been made. The purpose of these Farms would be to show, on a practical scale, the result of what has, by experimental trial on the smaller scale, proved to be beneficial. By means of them a new crop, or of brought home

a Experimental Farm alone, but along with it should go a Farm for demonstration purposes. In this respect there is a decided difference between India and England. In England the farmers are the demonstrators, and they are the distributing medium, but it is not so in India, and what is wanted is the connection between the Experimental Farm and the *rayat*. This it is which a Demonstration Farm can supply, and it should be the means of bringing to the very door of the cultivator practices and processes which have been proved experimentally to be better than his own. In this way the superior cultivation of one locality may be transferred to another where inferior cultivation prevails.

A Demonstration Farm should be expected to pay its expenses, inasmuch as it is intended to show what is the most profitable practice. At the same time a certain allowance must be made for the extra expense of hired labour, against which, on the other hand, must be put a fair subsistence amount for the *rayat* and his family, who would otherwise be occupying the land.

Experiments
and demonstrations
upon
private lands

476. Private Farms—In some cases it may be possible to induce cultivating landowners to undertake experiments on their own land, or it may be advisable, instead of having a separate Demonstration Farm, to have the demonstration carried out upon

a field in the actual occupancy of a tenant. If the latter be done, it may be necessary to guarantee the tenant against any possible loss arising from his having undertaken the trial, and to award him compensation for any loss of crop resulting from his having done so.

Where a private individual undertakes an experiment in this way, or gives his land for demonstration purposes, the portion devoted to this object should be under the notice and control of the Director of Agriculture, or of the expert assistants acting under him.

Judging from the number of instances in which landowners have already given part of their land for experimental purposes, alike in Bengal, the North West Provinces, Bombay, and Malabar, it is not likely that there will be any difficulty in obtaining whatever land is required.

In the North-West Provinces there are no less than six private farms used either as Experimental or Demonstration Farms. One of the largest is at Meerut, and belongs to Rai Bahadur Delu Singh, another near Cawnpore consists of 105 acres, and is conducted by Mr. Lachman Parshad, Personal Assistant to the Director of the Agricultural Department, North-West Provinces.

It has been urged with much weight that Court of Wards' Estates could well be made Demonstration Farms, for exhibiting what is found successful at an Experimental Farm, and of thus bringing the results to the cultivators' doors. This, it seems to me, might very well be done.

Another class of farm on which experiments, both with crops and with implements, might be conducted, is comprised in the farms attached to Government Breeding Studs, such as those at Saharanpur, Hapur (near Meerut), Hissar, and elsewhere.

477. It now remains for me to briefly review the different Experimental Farms which I visited. I do not purpose to go exhaustively into a detailed account of the different experiments then in progress, still less into the past history of the several Farms. What I wish to do is to remark generally upon the more prominent points that struck me when I went to each Farm.

Individual
Experimental
Farms

478. North-West Provinces.—Cawnpore Farm:

Cawnpore Farm
(North West
Provinces)

The first that I will take is the Cawnpore Farm, partly because after the Sadapt Farm (now practically abolished) it is one of the earliest Experimental Farms, and partly because it is the one which I visited most frequently, and followed most particularly. Indeed I made it a point to watch here the different crops at all the various seasons of the year.

Like many of the other Farms, and in spite of the representations made by those who carry it on the Cawnpore Farm is still generally known as the "model farm." It has been pointed out that it neither aspires to be a "model," nor yet is it a "farm" in the ordinary acceptation of the term. It is in reality an "experimental station" in the true sense to which is added a certain area for the purpose of growing selected seed. As such I am

ready to say that I consider that the Cawnpore Farm fulfils well the purpose of its establishment. It is a well-conducted Experimental Station, in a convenient position, and with a suitable soil, and though faults in detail may be found with it, the general conception and working of it are thoroughly good. The Cawnpore Farm is, I think, more like what an Indian Experimental Station should be than any other I met with in the country, although its younger rival, Nagpur, bids fair in some respects to threaten its leading position. The good work done at the Cawnpore Farm is due, in great measure, to the succession of good men who have had the oversight or the actual charge of it. From its inception in 1874 through the energy and interest shown by Sir John Strachey, it can claim to have had in the past the help of such men as Sir Edward Bock, Mr J. B. Fuller, and Colonel Pitcher, while, at the time of my visit, under the charge of Mr Muhammad

the superiority of the Farm's crops was most marked.

One way in which the Farm shows that its design has suffered is, that it

The Farm was started in 1874, and comprises 42 acres of experimental farming, and 65 acres of fruit and vegetable gardening. Included in the latter are 12 acres put in cereals for the purposes of growing seed for distribution. Attached to the Farm is also a workshop where ploughs, pumps, and other implements are made and sold, and where a collection of implements, both of Native and of European make, are exhibited.

The main objects aimed at by the Farm are —

1. To try new methods of cultivation, and to compare them with indigenous ones
2. To ascertain the probable out turn of crops for each year.
3. To try new crops and new varieties of crops.
4. To ascertain the effect of manures upon particular crops, and to try the value of new manurial agents
5. To test new implements
6. To grow and distribute selected seed.
7. To make and sell improved implements

The farm is very well placed, it is ready of access from Cawnpore, and yet is in the midst of cultivation, the soil is very typical of a large area in these parts. All that could be said is that the Farm is very well placed, and that the results are very satisfactory as to the present, in April, and nothing more could be said.

Without going into details of the many experiments which I saw in progress, I will just pass a comment here and there as it may suggest itself. In what is termed the "Standard Series Manure Experiment" a cold-season (rabi) crop, viz., wheat, and a rainy-season (kharif) crop, viz., maize, are grown year after year, the same manures being applied each time. This experiment has the great advantage of being carried out in duplicate, and the plots, which are 13 in number, are of fair size, viz., 400 square

The last of the permanent series of experiments, the foregoing being all carried on year by year, is one upon the effect of ploughing for wheat with native ploughs and with improved ploughs to different depths. This is a useful experiment but the plots being only 300 square yards seem to me rather small to accurately test cultivation operations of the kind I would prefer to see it done on a considerably larger scale, as the frequent sowings and treadings on a small plot are likely to affect this result.

After these permanent experiments follow a number of others of more or less temporary duration, upon which I need not dwell long.

At present the indigenous system, the early and late sowing of imported cotton the plots on which

the varieties of cotton are grown are somewhat too small to test the question of out turn thoroughly.

With sugar-cane different methods of sowing including indigenous ones are compared, the yield of different varieties of cane, and the value of cane left for a second year, are tested.

Experiments upon indigo include trials of the use of gypsum as a manure, and the difference of early and late sowings.

Manurial experiments upon wheat are made with cotton-seed cake and mustard cake as against ordinary cow-dung and dung made by animals fed with cotton seed.

Then there are further manurial trials with kaimit and woollen refuse on

Better than the last is an experiment on different varieties of wheat the white) is one very

Varieties of barley have also been tried and a white huskless variety has been very successful.

Lastly, manurial experiments have been made with gypsum upon leguminous crops, and with goodrille woollen refuse kaimit gypsum and castor cake upon potatoes the latter manure being as before, open to the objection attaching to woollen refuse and kaimit, the experiments are satisfactory in most other respects.

There are also trials of various manures and on the whole, a very satisfactory result has been obtained, but, so far as the main points are concerned, with an existing practice.

In addition to the above, there have been attempts from time to time to introduce new crops, such as Guinea grass (*Panicum zosterifolium*) for fodder, and the variety of *Sorghum saccharatum* known as sorgho.

The general out turn of crops has been estimated from plots grown on the Farm, in order to check the forecasts made for the Province. But this is not satisfactory, for so much depends upon whether the land has been watered and manured or not, at Cawnpore cattle manure is used and canal irrigation is available. The general out-turn of wheat in 1888-89 was about 22 bushels per acre over the Farm.

Implements have been extensively tried at the Farm including different kinds of sugar mills, sugar-evaporating machines, ploughs and pumps. These have been referred to in Chapter XII, paragraph 286. The extensive seed distribution carried on has been spoken of in Chapter XIII, paragraph 310.

Another useful purpose which the Farm has served is, in having been the training ground of a number of apprentices who have subsequently gone out to other farms.

The Assistant Director, in summing up a recent Report, expresses his belief that the Farm has a real, though possibly slow and limited, influence on the native agriculturists. People often come to see it and the services of farm apprentices and labourers are often borrowed. Thus, one was sent from here to the Central Provinces, to teach the making of the unrefined sugars termed *gur* and *ribbi*. Apprentices also come from other places to learn on the Farm.

The Farm Report (I refer to that of 1898-99) has a good and clear description of the experiments and their aim. I would point out that its chief fault is the complication of the results by the giving of so many columns in the tabular statements. Again, it would be well to adopt greater uniformity of nomenclature; for instance, in several cases, *bighas* and *acres* are mentioned together, and in other cases *bighas* and *square yards*.

The danger, as regards the future, is that owing to the large number of monoval experiments, the land will be affected so unevenly that it will be a difficult matter to find space for fresh experiments when needed, or, what is worse, the results of the trials will not be accurate, owing to the difference in the previous treatment of the plots composing them. I hardly think that monoval experiments are the most important ones in India, for the difficulty is to get manure of any kind whatever. I would rather see more space given to experiments in methods of cultivation. There should also be a reserve of land kept over, treated and cropped each year much alike, this would serve for the extension of experiments as required. I should also like to see considerably more duplication of experiment. It is not so important to get a large number of results as to make sure that those given are correct, and this can only be verified by repeating them, not only on the same spot but on fresh land, and in a succession of years.

It seems to me that the Farm might well be made use of as one at which stud bulls could be located for the breeding of good farm cattle. There are great complaints in the neighbourhood that the Brahman bull is getting scarcer and scarcer, and the Farm might in this way supply the deficiency.

479. Gardens at Saharanpur and Lucknow

Gardens at
Saharanpur and
Lucknow

Not altogether of the nature of Experimental Farms, though in the origin intended to be more or less so, are the gardens at Saharanpur and Lucknow. Formerly, experiments were carried on at these, but little of this work now remains the gardens being worked on a commercial basis and being really only used for the sale of plants and seeds, the supply of drugs to Government stores, and for the training of gardeners.

Some experiments have been tried on the acclimatisation of English varieties of wheat, on the growing of the date palm (*Phoenix dactylifera*) and other plants but now there is hardly any of this work done, and though they form pleasant recreation grounds and do good in providing plants and seeds for sale, the gardens can hardly be classed as Experimental Farms, but only as Nurseries, which, in India, take the place of those of the florists and seedsmen of England.

480. Central Provinces—Nagpur Farm

This is one of the more recently formed Stations, it having been started on its present plan in 1883, although previously to this a large "model farm," as it was called, of nearly 400 acres had existed. The present Farm is about 90 acres in extent 67 acres being experimental and it is based upon the model of the Cawnpore Farm, this being accounted for by the transference of Mr. J. B. Fuller from the North-West to the Central Provinces about that time. The out of pocket expenditure on the Farm in 1888-89 was Rs 3,741, and in 1889-90, Rs 6,801, this latter including the

Nagpur Farm
(Central
Provinces).

amounting to 33 per cent in one case and 42 per cent in another, between the weights of green stuff put in and the slag taken out are far too high. Where silage is to be made every year, I would certainly advocate brick or masonry silos in preference to those merely dug in the soil, which have only earthen sides and bottom.

The out turn of crops is gathered from other plots on which some 12 different crops are grown. So much depends, however, on the soil and the manuring given that the results are but of limited value.

With cold season (rabi) crops trials have been made on the effect of embanking land in the case of wheat and linseed. The results are not encouraging but the native method had not been properly studied previous to the commencement of the trial.

Green manuring, or green-soiling, as it is inaccurately called in the Report, has been carried out with wheat and horse-dung and in another part different manures; such as bone-dust, gypsum, dung, and hemp, have been tried. In neither case are the results properly comparable.

The most satisfactory series has been the permanent one on the manuring of wheat, this crop having been grown year after year, with the same manures each year, these being, all of them, such as might well be used for wheat. The existence of this experiment in duplicate adds much to its value. What is wanting in the statement is the cost of the manures. The duplicate experiments agree very fairly with one another, several distinct losses are brought out, and the influence of season is checked by the repetition year after year; altogether, the experiment is a very good one.

The averages are also given for the past five years and the following interesting comparisons with the Woburn (England) experiments for 10 years may be drawn:—

—	—	Manures per Acre	Produce of Wheat. Hushels per Acre	Produce of Straw Cut per Acre
1	{	Nagpur	33	8
		Woburn	17	17
2	{	Nagpur	29½	14
		Woburn	24	25
3	{	Nagpur	16½	—
		Woburn	21	—

An experiment more of the nature of scientific enquiry is that termed "the Ville series" which is a trial of superphosphat plot, and on rest put on, requires most chloride, ed on one and the the plant

In addition, trials have been made with different sugar mills different varieties of wheat have been grown selected cotton seed has been distributed to cultivators and a limited number of new implements have been sold.

But one of the chief functions which the Farm performs is that of being the training and instruction ground for the Agricultural Class, of which further mention will be made in the next chapter.

The Nagpur Farm has not had the advantage which the Cawnpore Farm enjoys of being old enough for the character or the qualities of the land to be sufficiently brought out, and there is still a good deal to be learnt about

it before experimental work can be fully satisfactory. Besides this, the soil does not appear to me so well suited as the Cawnpore one to the purposes of experiment. In general, the plan set forth is good, and the details are accurately carried out, but the results require a good deal of careful sifting before it can with any safety be stated that a definite conclusion is warranted.

At the close of the Report is a summary of the "Record" of results. The results are not very satisfactory. Agricultural results are not very satisfactory. Both useful and ornamental results are not very satisfactory. Again to the same effect. The results are quite diverse, and the consequence is, that it is a conclusion too faulty from any reason, it is brought in time after time, and may lead to other faulty conclusions being drawn, even where the immediate premises are good.

Bombay Farms

481. Bombay Farms—The Bombay Government owns two Experimental Farms, one at Poona, the other at Bhadgaon, near Pichora, in Khândesh. But neither is experimental in the full sense, the Poona Farm being used mostly for educational purposes in connection with the agricultural branch of the Poona College of Science, and the Bhadgaon Farm approaching more to a "Model Farm" than any other in India, and being also devoted largely to the breeding of cattle.

The Farms are the outcome of the movement in 1869 to establish "Cotton Farms" in India. At the time of the American Civil War attention was turned to India as a main source of the future cotton supply, and, accordingly, "Cotton Farms" were established throughout that country under the charge of men sent out from England, but who, as a rule, were really nothing better than gardeners. After the Civil War was over, the cotton trade returned to its normal state, and the Farms then became Model and Experimental Farms, and were transferred in 1873 from the Cotton Commissioners to the Provincial Governments. In a few cases the "cotton farmers" brought over were retained as Managers of the Farms, but in most cases they were found unsuited for the duties.

Bhadgaon Farm

482. The Bhadgaon Farm

comprises 1,200 acres, of which only 65 acres are experimental, and 600 acres are used for grazing and as Rs 890, not including the cost of the land, it was Rs 3,743, including the net cost to Government.

It is not an Experimental Station in the sense that Cawnpore and Nagpur are, but is really a farm where improved cultivation is attempted, where cattle are bred and where, now and again, a few experiments are tried over a limited area.

Regarding it simply as a Farm, I may express my opinion that I think it is carried on very ably, and that it is doing genuine good work, although the results are not very satisfactory.

as small as it is. The amount spent is really very trifling, and the advantages it is likely to afford in the future as a training ground, when agricultural education is more developed, will be very ample obtained. I am quite sure that few of those who complain of the expenditure incurred can have been at the Farm, or have taken the trouble to see how it is actually worked, or how favourably it compares with the cultivation around. Least of all can they have seen the excellent herd of cattle, or have noticed, as they might most easily have done, the impress which it is beginning to make upon the stock of the district. There are respects, undoubtedly, in which the Bhadgaon Farm might be improved, but it is, I am confident, on a basis of which the Bombay Government and Agricultural Department may very well be proud. It is surprising to me that the expenses are so nearly met, for it has to be remembered that the produce of the different fields is all gathered separately, and thrashed and weighed separately, many records have to be kept, and hired labour has to be employed. If the crops could be all put together, and thrashed and stored at once, the Farm would be able to pay its expenses quite well, but then it would be a pity to lose the information that can be obtained here. Seeing this, I do not think that the Superintendent ought to be needlessly tied down by considerations of cost. It would be much better to devote annually to the Farm a certain sum which past experience has shown it to require, and so long as the Farm is conducted as at present, the Bombay Government may be assured that the money is not being needlessly expended. It is reckoned that about Rs. 5,000 a year are wanted, and I should not call this out of the way, seeing that the out-of-pocket expenditure on the Woburn Farm of the Royal Agricultural Society of England amounts to nearly £600 annually and the acreage is about the same as at Bhadgaon. I cannot help noting the tendency of Commissioners and Collectors, and Under-Secretaries, who report on the Farm, to devote their remarks principally to the financial side, and to say but little as to the way in which the Farm is influencing the agriculture, and more especially the cattle, of the neighbourhood.

I need not say more than I have given in Chapter XI (paragraph 255) about the cattle breeding operations at Bhadgaon in order to show that the Farm is doing good. The readiness of the people to buy the young stock is a proof that the operations are appreciated. It is to stock-breeding purposes that the Bhadgaon Farm should be more particularly devoted, and this has now been recognised by the Government. Forty acres of land have been set apart for field experiments, but beyond this it is not intended to carry on remunerative trials. This area has very properly, been sown all over with wheat, and before beginning any regular experiments conducted here upon the present kinds of wheat and barley, I sowed also grain and the growth of special crops and trees, such as arrowroot, *disi-disi* (*Caesalpinia coriaria*, a material used in tanning), mangoes, and guavas, as also on the making of silage and the trial of certain implements. More recently an experiment has been started on the cost of establishing a "fuel and fodder reserve." This I have referred to in Chapter VIII (paragraph 186). Silage has been made without difficulty, and since I left India the experiment has been tried to make a "stack silo" in the open, instead of digging a pit in the ground. Mr. Gzanne, the Director of the Agricultural Department, is endeavouring to keep up the supply of pure *bani* and *yari* cotton (Berar long-stapled varieties) by growing them at the Farm, as also American varieties which have been acclimatised at Dharwar. A certain amount of selected seed of different kinds is yearly distributed from the Farm, and there are seven iron saw-mills which are let out on hire in the district. Goats thrive well at the Farm, and have now replaced the sheep with which it was intended to try improvements. The cattle are a pedigree herd of the Mysore breed, known as *Khillars*, and Malvi cows are kept as nurse cows. A Government stallion (Arab) is also located here, but is not much appreciated as yet.

A great fault of the Farm is its isolation, it is hard to get to and consequently cannot be easily visited. Half-a-day's journey has to be taken from the nearest station, and several rivers have to be crossed or forded.

The Farm is unnecessarily large, and is not suited as an experimental area. The distance from any large town makes the sale of the produce not so remunerative as it would otherwise be. In many ways the cultivation is superior, and I noticed here an attempt made to preserve the cattle-manure. A large quantity is made and kept in a pit, but it might be improved in quality if better stored, turned over occasionally, and then heaped together more closely, it was allowed to lie too loosely and to become too dry; a large amount of straw and stalks, which might quite well have been used for litter, was left in a dry state, and not mixed up with the cattle-droppings and so allowed to decay, while the urine from the sheds was wasted to a considerable extent, and during the rainy season it mingled with the rain water from the roofs of the sheds.

There is an educational purpose that the Bhadgaon Farm might usefully fulfil. It would be a capital place at which to send into residence for a time the agricultural students of the Poona College. Here they might see carried out on a practical scale what they had learned theoretically, and they might do the actual farm work themselves at Bhadgaon. A practical class of this kind, following upon the instruction given at Poona, would be of great benefit.

The Bhadgaon Farm might also be utilised as a place to which apprentices might come and receive a practical training before going out to act as managers of estates, or to look after their own landed property.

Poona Farm.

483. The Poona Farm,

as I have said, is not an Experimental but rather an Educational Farm. Different crops are grown, and their yield is estimated, a few cattle are kept and an attempt has been made to estimate the relative milking properties of different breeds, but on a scale far too small to be of any use. What has been done here has been done in connection with the College of Science.

Silage has been made here, but no light is thrown on what the cost has been, or whether the system is remunerative. The manure from the cattle is very badly stored, the urine is almost entirely wasted, and the manure heap is little more than a dry rubbish heap. A great improvement in this respect might be made, more especially at a place where students come for instruction.

In one case a comparison has been tried between *Khandesh yam* (*Sorghum vulgare*) and the local kind grown, but, as the previous crop was partly sugarcane and partly gram (pulse), the plots did not start under level conditions.

As a place where the students of the College can come and see different crops grown, and become familiar with them, and with the outlines of farm operations the Poona Farm has an educational value, but, inasmuch as the students do not work on it themselves, it would seem to me very desirable that during their course they should be sent to the Bhadgaon Farm, where they could see the work carried out on a practical scale. It should also be mentioned that at Poona Mr Ozanne has got together a very complete collection of native agricultural implements.

There used to be another Farm at Hyderabad, in Sind, but there is no longer a Government Farm, it having been given up in 1889. The experiments here were of no value.

Sisal Farm.

484. At Nadiad, in Gujarat (Bombay),

there is a Farm of 12 acres, inaugurated in 1879 and kept up by the Agricultural Association. It is made use of in connection with the Agri-

cultural Class attached to the High School. The soil is a rich red garden loam, and very deep.

Manual experiments form the principal work. These are upon *rigi* (millet), *fur* (jowar), and *padr* (millet); also an extensive series upon tobacco, to which reference has been made in paragraph 269. Different varieties of cotton, American and indigenous, as also of the castor-oil plant are tried. Male buffaloes are used in ploughing, a practice not locally adopted, but which it is sought to introduce and iron ploughs are also employed. There is a museum attached to the Farm, containing specimens of cotton, cereals, etc., and in the town is a seed store maintained by the Association, where pure seed can be got by cultivators. The Farm is given rent free by Government, so long as it is available for the Agricultural class; the yearly expenses, amounting to Rs. 400 are more than covered by the out turn. The Association hold a Cattle Show biennially at Nadiad.

485. In the *Native State of Baroda*

Farmers for
Baroda.

experimental work bids fair to make a good beginning for not only does His Highness the Gaekwar take a great interest in agriculture, but he has also secured the services of Mr. Middleton, formerly a distinguished agricultural student at home, as Professor of Agriculture at the Baroda College. In company with Mr. Ozanne and Mr. Middleton I went over the proposed Experimental Farm, and I need but say that I am sure that what Mr. Middleton does he will do well, and his presence in India will be a distinct gain to agriculture in that country. As the experimental area had not been taken up when I was there, it is of no use for me to refer further to it, except to say that I look to much good resulting from it, as Mr. Middleton is, perhaps, the first man who has come out to India who has combined a practical acquaintance of agriculture with good general knowledge of agricultural science.

and at great cost, too, but with utter disregard to the conditions of Indian agriculture. Here, for example, was a huge waggon from Germany, used in that country for bringing brewers' grains and beet root pulp and distilleries and requiring perhaps, some six horses to draw it! Here, too, were huge iron seed drills, heavy iron ploughs, manure distributors and seed-barrows so had a set of

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In addition to the Farms in the Bombay Presidency here mentioned there are fruit gardens at Ganesh Khind near Poona, comprising 80 acres, and devoted to the growing of mangoes and more especially to the propagation and sale of grafted mango trees. This culture is also carried on to a more limited extent on a part of the Poona Farm. A large quantity of grass is cut green from off the Ganesh Khind plantations.

Fruit Farms

487. The plans for future experimental work in Bombay comprise the establishment of a Stock and Dairy Farm at Alegaon and the starting of new Experimental Farms of small extent in five or six different districts of the Presidency, notably the Southern

Future pen in Bombay

The cattle I saw at the Farm were 12 Nellore cows and 16 Nellore and Aden bulls, and they were very good indeed. The bulls are kept for stud purposes, and their services are available, at a low fee, for stock belonging to cultivators, but they are not much made use of. I have mentioned previously an experiment carried out on sheep; four being fed on earth-nut cake with other food, and four without the cake; but I pointed out also how inadequate the number of animals was for the purpose (see paragraph 434).

There is, however, one point that the Saidapet Farm has done very considerable good in showing, viz., that cattle can be kept perfectly well on the "box" system, that is, with litter under them, and that the manure obtained in this way is far more valuable than that got in the ordinary way. During my Madras tour I came to one or two farms where cattle were littered, and manure kept in heaps, well beaten down and covered with earth, and I think the Saidapet Farm has done a useful work in demonstrating the advantages of the system. I am sure that its adoption would be one of the best ways of benefiting Indian agriculture, that is, by making the manure supply more valuable, and allowing less waste to take place.

No Experimental Farm has worked harder than Saidapet in trying to introduce iron ploughs, and here and there (more especially where there has been a considerable area to till, so that time has been a matter of importance) some few iron ploughs are used by landed proprietors; but they have hardly come down to the small cultivators yet, though much ingenuity has been expended on simplifying them, and on decreasing their cost.

489.

Madras Farm

I visited at Madras what was formerly the Experimental Farm of the Madras Farmers' Club, but which has now been given up, except so far as the dairy part of the Farm is concerned. It comprises 30 acres, and was started in 1833, under the care of a student from the Saidapet College. Experiments were carried out with improved ploughs and water-lifts, with fodder-crops and tobacco, and on the breeding of stock. But it does not appear that any definite fresh experience was gained, and interest was soon lost in the Farm. There is, however, a ready sale for milk in the town, and this part of the farming has been kept up and pays well, there are some 24 cows in milk, very fair cattle, some of them Aden cows, the others country stock, and they are fed with earth-nut cake, fodder-crops, etc. The average daily yield of milk per cow is 12 lbs.

Report of Madras
Agricultural
Committee 1890

490. In September 1898 an Agricultural Committee was appointed to enquire into the operations of the Madras Agricultural Department, and the Report of this Committee was presented to, and considered at, the Agricultural Conference at Simla, in October 1899. As regards Experimental Farms in Madras, the Report does not speak favourably. Efforts at improvement have been made, but

unity of growing fodder-crops, have been shown, but very little more, and efforts have had but little practical result. The Report indicates that the chief reasons of failure have been the absence of an organic Department, an insufficient staff, imperfect supervision,

enquiry, more is known as to the native practices and conditions. The Committee also advise the inauguration of experiments under the control of trained agriculturists. It is now proposed to have experiment and demonstration carried on at some five or six Farms, each not exceeding 30 acres in extent, in different parts of the Presidency. Each is to be a combined Agricultural School and Farm, or Farm School. The Farms are to be under the management of the head master of the school, who is to be a graduate of Saidapet College, and acquainted with agricultural practice. Mean time the Saidapet College and Farm are to be retained as training grounds for future teachers.

I have already thoroughly endorsed the recommendations of the Committee as to the necessity of abandoning the attempt to teach the *rasyat* until more is known, through careful enquiry, of what his practices really are, and the conditions under which he pursues them. I am not of starting at once some fi

mental, partly educational the country. If there be efficient and sufficient supervision for them the plan may be adopted with benefit, if kept to a limited scale, and if the sites be suitably chosen. It is said that there are qualified graduates who have passed out of Saidapet College, and that they could be utilised as Superintendents of the Farms. Of their qualifications for such posts I can hardly speak, but I cannot help noting that the Government Order (No 515, Revenue 4th July 1900), which, in paragraph 12, approves of the plan recommended by the Agricultural Committee, also says, in paragraph 11, "special instruction in agriculture, however, is almost non-existent, owing to

tent superintendence. Unless this be the case, Agricultural Education would be better helped by Farms of a purely illustrative character.

Nor can I agree with the recommendation to extend the Saidapet Farm to a suitable place. I have read of an Experiment do so, suitable with

Agricultural Committee's Report, to the effect that, even if the soil be poor, as described, it should be possible to improve it and to show what the *rasyat* cannot show this it must be remembered In India on which any thrown away, there may be soil that is not worth reclaiming or

one may pass through the other, and so be wasted; on certain lands of good productive power it may pay perfectly well to use, say, 2 cwt., or even as much as 4 cwt., per acre of nitrate of soda, costing from 20s. to 40s. an acre alone, whereas on another soil even $\frac{1}{2}$ cwt. of nitrate of soda an acre would be thrown away. Again, a great deal depends upon what the crops may be, and what the market conditions are. An English farmer would not grudge to spend large sums in manure if he could get thereby, say, an early crop of potatoes; but if they came a fortnight later, a loss instead of a gain might result, though the potatoes might in either case be equally good in themselves. So, too, with *barley*, and, it will not pay to go on with a *barley* on a favourable soil, situation, and kind of *barley* can be grown, a good return for outlay is ensured. I have laid it down as a condition of success in experiment that the soil must be fairly responsive to manure and cultivation, and if one has to do with a bare sand or soil like that of Sandpet, the improvement in a medium unworthy to it. The best to do is, not to see *how much* can be sunk in it in hope of getting benefit one day, but *how little* need be expended upon it. I maintain that the chief end of experiment is to see how land that is fairly productive can be got to produce more, and not how land that is not fit for cultivation can be brought under the influence of methods and practices applied in England and elsewhere to the increasing of the crop-return. There may be circumstances where the restoration of deteriorated soil is called for, but I do not think that the credit of an Experimental Farm, whose object it is to introduce practices applicable to the increase of crop in cultivated and culturable soils, should hang upon the results obtained upon what is little better than a sand-hill.

491. *Bengal Farms.*—Experimental Farms in Bengal are three in number, and they are all of recent creation, for, previous to 1884, there was no Director of the Agricultural Department of Bengal. The three Farms are Dumraon and Burdwan, both established in 1885, and Seebpore, started in 1887. I visited Dumraon and Seebpore, but not Burdwan, indeed, the position of the latter is so unfavourable that it is contemplated to give it up

Bengal Farms.

492. *Dumraon Farm*

covers 15 acres, and is intended to be an Experimental Station in the stricter sense

Dragon Feet

The Maharajah of Durnston pays all the expenses, which, including the overseer's pay of Rs. 600 and rent, amount to a net cost of Rs. 1200 annually. An overseer was obtained from the Cawnpore Farm, but he can only give partial attention to the Farm, having the charge of other parts of the Durnston Raj, or Estate, as well. Occasionally, one of the Assistants to the Director of the Agricultural Department visits the Farm, perhaps once

or twice a year, but it was evident to me, from the state of crops, that there was a lack of regular supervision.

The first experiment I noticed was one on the growth of sugar cane with different manures as well as by trying the Native against the Mauritius plan of sowing. But the sugar-cane crop was growing on land that was too wet for the Native plan. As an experiment this one was inferior. It had little relation one to the other, salt-petre, and a mixed manure termed

nutrient manure. In choosing manures, they ought to be arranged with some regard to their constituent parts, so as to enable an experimenter to gain some information as to whether it be the nitrogenous, phosphatic or potassic properties, or else the presence of vegetable matter, that proves most effectual, this point solved more special experiments can be tried with materials containing the particular ingredients. But here the state of the crop rendered comparative results misleading. Where the native and Mauritius system of planting were compared, the question was further complicated by manual issues as well, this seems to me very undesirable. Single issues should be set out as far as possible, and these only. There were no duplicate plots at all.

The next series was on the manuring of winter rice sown broadcast; 15 plots (a far too large number) were taken up though in no case with duplication of experiment. Shallow and deep ploughing for rice comprised two of the plots, a slight advantage being attributed to the latter. The manures used were, as before, of a very varied kind, and allowed of no deductions being drawn except as concerned the actual material employed, but supplied no information as to the most desirable class of manure whether vegetable, or phosphatic or saline. Green manuring, cow-dung lime, salt-petre, oil cake, and sweepings were tried. Salt-petre, either alone or with lime, gave the best returns but, on going into figures its use is found not to have been financially successful. This I can well understand and it seems to me to need little practical demonstration to show that a very readily soluble salt like salt-petre is thrown away upon a crop that grows frequently with an inch or so of water standing on the ground.

Another series on the same lines, but with transplanted instead of broadcast rice, followed.

The next was on wheat, with the same manures as were used for rice. Here, again, salt-petre gave the best returns, though the increase is stated to be year by year a declining one.

I cannot say that I considered the Dumson Farm a good Experimental Station. The first mistake made with it was to take up the whole area, to divide it into squares and to cram in as many plots as would well go into the space. The consequence is that there is no room for extension of experiment, or for re-testing what has been done. Then, as all the experiments are manual ones, the ground is practically done with, so far as future experiments are concerned unless with a considerable break of crop-growing without manure.

Next, there is no duplication of plots, and more especially of unmanured plots; nothing seems to have been done to test the suitability or evenness of the land for experimental purposes, and, indeed, the Report says "the surface of a large portion of the Farm is uneven, and, unless it is properly levelled, it is idle to expect a uniform growth of crops. As it is, these may thrive sufficiently well in the hollows, and get stunted and burnt up in the intervening patches of high ground. The unevenness of the ground also stands in the way of irrigation." This to my mind, surrenders the whole point as to the Farm being a good Experimental Station, let alone what I have said as to the absence of supervision and of design in the plan of experiment.

493. The Seabore Farm

is only a little way out of Calcutta, and includes about 26 acres, of which 18 acres are experimental. The soil is rather heavy alluvial land with a good deal of clay. It was formerly jungle land. Its depth is about 2 feet, and

Experiments
through re yals
and confidare

495 The foregoing account embraces the Farms which I actually visited when in India. The remaining ones that exist, but which I could not see, were those in Burma; these, I believe, are devoted mostly to the growing and curing of tobacco. The attempt has been made to grow wheat also, but the people do not take to it, as rice grows so much better. In Berar there used to be a small experimental field, but it is now given up, so also is one that formerly existed at Ajmere.

In the Punjab, in Assam, and in Coorg, there have not been any Experimental Farms.

CONCLUSIONS.

CONCLUSIONS.

496. Experimental enquiry, conducted by means of special Experimental Farms, is a necessity in India for the development of agricultural improvement. It may be urged that the Farms which have already been in existence for some number of years have not been pronounced successes, and have fallen far short of what they were intended to accomplish; but, after visiting the Farms, and after reviewing the work done at them, I can only express my satisfaction at finding them so much better than I had been led to believe, and my surprise is great that so much has been accomplished with the imperfect and ever-changing machinery employed. The expense incurred for Experimental Farms, though perhaps rather large here and there, has, in my opinion, been by no means excessive, and the Farms compare very favourably in this respect with similar institutions in England and other countries.

What is chiefly needed now is, that there should be a better system of guidance in laying out the plans of experimental work at Farms, better supervision, continuity of enquiry, critical examination of results, and publication and dissemination of useful conclusions in a clear and intelligible form.

In accomplishing this, the association of a "scientific adviser" with the work of Experimental Farms will be invaluable.

Farms, omitting those directly connected with educational institutions, should be of two distinct kinds, (1) Experimental Farms, and (2) Demonstration Farms.

The work of Experimental Farms should be, mainly —

- (a) To institute comparisons between methods of cultivation practised locally, and those in use elsewhere, which it may be considered desirable to introduce.
- (b) To test upon different crops, the effects of manures which are available, or which may probably be usefully applied in the future.
- (c) To introduce new crops and new varieties of crops.

- (d) To institute trials of new implements side by side with native or locally used ones.
- (e) To improve the breeding of farm stock.
- (f) To grow and distribute selected seed.
- (g) To be Depôts for the locating of stud bulls.

Before any Experimental Farm is established, there should be a definite reason for its existence; there must be efficient supervision, a suitable situation and soil. A definite and well-devised plan of experiment should be drawn up, the outcome of the experiment having a distinct bearing upon the practice of the cultivating *raiyat*. There must be critical examination of the results, duplication and repetition of experiment, and, finally, publication and dissemination of the results, the issue of these in the vernacular not being omitted.

The success of Experimental Farms must not be gauged by their financial result, and they must not be expected to pay their expenses; but a sum of money ought to be laid out annually for their efficient carrying on.

Demonstration Farms should be established for the purpose of showing on a practical scale, and of bringing to the door of the cultivators the results of what has been found on Experimental Farms to be an improved practice. Such Farms should be expected to pay for their cultivation expenses.

RECOMMENDATIONS.

RECOMMENDATIONS,

- 497. That agricultural enquiry be continued by means of Experimental Farms.

That distribution of selected seed and location of stud bulls be undertaken by Experimental Farms, as also the breeding of farm stock, where circumstances are favourable.

That Demonstration Farms be instituted in connection with Experimental Farms, in order to set out the results of successful enquiry.

CHAPTER XIX.

AGRICULTURAL EDUCATION.

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AGRICULTURAL EDUCATION.

498. It is not enough that improvements in agriculture should be effected by direct Government agency, and that measures, the result of enquiry and experiment, should be taken in the people's behalf. But it is necessary also that the people themselves should have a better understanding of what is being done to teach them how they can do the work of education. In my second and third chapters I have shown how the spread of General Education will aid in removing many of those prejudices associated with "caste" and custom which render one class inferior to another in cultivating ability, and which frequently prevent the adoption of the more remunerative agricultural systems. This work, it was pointed out, will of necessity be a slow one, but it is a sure one, and will gradually remove the obstacles which have hitherto stood in the way of agricultural education, and will enable the people to be more ready to receive new ideas.

The influence
of General
Education.

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cation
afraid
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vances
more

499. It is not, however, with General Education, but with Agri-
cultural Education, that the obligation to promote
Agricultural Education.

close attention which the Agricultural Conference at Simla gave to it, and in the several Resolutions which were passed upon that occasion.

500. For myself without a knowledge of the languages, and a very limited one of the people, it was much harder to come to a
My enquiry
limited.

tural Education, again, cannot be taken out of its connection with

General Education, and I had neither the time nor the power to acquaint myself with the systems of general education as carried out in different parts of India. My observations upon the various grades of schools where I think that agriculture might enter as

therefore, not be assigned to
practical and not of general appli-

The tendency
of education in
the past

501 There is very little doubt that the tendency of education in the past has been too much in a purely literary direction, and that it has been diverted from, rather than turned towards, the staple industry of the country, viz., agriculture. Agriculture is by far the most general pursuit, and it is that which contributes the bulk of the Revenue of the country. According to the Census Returns of 1881, 72 per cent. of the whole male population engaged in some specified occupation are directly supported by agriculture, and the estimate of the Famine Commissioners was that 90 per cent. of the rural population live, more or less, by the tillage of the soil. Nevertheless, it is found that the tendency of education at the present time is to draw the rising generation away from the land, and to give a purely literary training, which ends in a young man making his aim the obtaining of a post under Government, or the following of the profession, of a "pleader" in the Courts. Agriculture is not regarded as a profession, but too often as a medium for deriving an income off the land, owners of land do not look after their property

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now managed by men on a pay of Rs 25 a month, there is no intelligent farming class. A young man, after leaving school, goes to a farm, but soon

is at the Bar, or else in Government employ; the student at an Agricultural College will rather take a Government appointment worth Rs 50 a month than devote himself to the management of his farm, or superintend that of some one else, and, lastly, there is a general feeling that agriculture is a less dignified occupation than that of a Madras extra-magistrate, or the next into agriculture or else to

alliance.

The following extracts may be given in support:—

Sir E. Buck's
opinion.

"The fault of our educational system is, that nothing in the scheme of instruction sufficiently connects the knowledge to be acquired by the son with the cultivation of the paternal acres." (Sir Edward Buck's Minute on Technical Education, 1886.)

Sir A. Mackenzie's
opinion.

"There is need of something more than a purely literary curriculum for our graduates. We have schemes by the score for reforming the Empire, but no idea of exploiting and developing its resources." (Sir A. Mackenzie's Minute on Technical Education, 1886.)

Mr F. A. Nicholson's
opinion.

"The education given has little or no connection with a lad's after-life. There is nothing in it to teach him to farm; it does not teach him to observe, or think about, or think new thoughts about, his processes and products." (Mr F. A. Nicholson on the Condition of Anantapur, 1887.)

502 The present system of education is not sufficient to create and maintain that interest in the cultivation of the land which ought to be taken in an essentially agricultural country, and the only way to effect this is to substitute Agricultural Education for a part of the present educational programme. The advantages of such a course would soon be apparent, for, where so large a proportion of those who are to be educated are brought up amid rural surroundings it must be simpler to bring before them objects which are familiar to them in their every day life, than to instruct them in the literature and history of a foreign country totally different to their own. The benefit of a more technical course of education is, that it maintains the connection between the teaching which a lad receives and the calling which he is to follow in after life, in no branch could this be more important in India than in agriculture. The teaching of the rudiments of science also is far more likely to lead to habits of observation, and of desire after enquiry than a purely literary training. Even in the very simplest form of education the illustration of the lesson by means of the ordinary objects and operations of agriculture is the most ready help, and is more likely than anything else to awaken the interest of the scholar and to bring home the lesson to his comprehension. Object lessons can nowhere find more apt illustrations. Then as we go higher in the scale of education, the same subject is fertile in ideas familiar to the pupil, and then it is that an effort should be made to awaken his interest in the great industry, and to impart a knowledge of its principles which may be of use to him in his after-career. Nor need this interfere with the course of a lad's general education in reading, writing, etc., it merely helps his comprehension by bringing before him familiar objects and gives him later on the opportunity of utilising the knowledge of those elementary principles which he has learnt in his early days. When, as I have shown, the problem of agricultural improvement is so great a one it becomes all the more necessary that early in life a sound teaching should be imparted in the elements of agriculture, so as to enable those whose lives will be largely spent in its pursuit to enter it with a fair understanding of its aims and guiding principles.

503 The Agricultural Education of the masses, though it is what must be aimed at, can at first have no immediate effect. There are not merely the scholars at the different grades of schools to educate but there are also the teachers who will require systematic instruction before they can properly direct the training of their pupils. All this will require time to develop but the sooner the work is begun the better. In addition, there are landed proprietors who require education in agriculture, there are the future "agricultural experts" to whom the work of enquiry is to be entrusted and lastly, there is the large class of subordinate officials of the Land Revenue Department for whom an agricultural training is an undoubted desideratum.

504. The existence of different classes for whom Agricultural Education is to be provided in the near future points to the necessity of beginning the work, not from the lowest level alone nor yet

The remedy and its benefits.

Progress must at first be slow

The direction in which Agricultural Education should proceed.

from the highest as it would be a higher type, and of nature without the accession of men it be equally unwise to delay the commencement of the education of the masses until a fully competent teaching element had been provided, which might cause the stream of agricultural instruction to filter down from the upper to the lower classes.

... high class training, and have in their turn become fitted to be the instructors of other more elementary teachers. In short, I think that the work of high class and of elementary instruction in agriculture should go on simultaneously, and that no system will be satisfactory which does not provide for both.

A University training such as can be provided at Colleges and special Institutions is requisite for the instruction of those who may be fitted to occupy the higher posts of the Revenue Service, or to enter the Agricultural Department as "experts"; so also for those who will become ...

... and Agricultural Department, or who may qualify as teachers of lower schools, sound Agricultural Education of a more elementary nature will manifestly be called for also.

It is not, therefore, a question of whether education shall proceed from above downwards or from below upwards, but progress must be made in both directions simultaneously.

Special
Agricultural
Colleges not
required.

505. Taking, for convenience' sake, the highest instruction first, we have to deal with such agricultural education as would be imparted at Colleges or special Institutions where agriculture forms one of the subjects taught, and where students prepare for a University degree or career. The Poona College of Science and the Sardarpet College at Madras are instances of such Colleges.

The question arises at once, whether agriculture in its different branches should be taught at special Agricultural Colleges, or whether it should merely form a part of the instruction at existing Colleges where a general training in science is given. Its origin Sardarpet ... of the latter. After ... favourable to the establishment, at the present time, of special Institutions for the teaching of purely agricultural subjects alone, but I advocate rather the utilisation of existing institutions where a training in science is given, and the tacking on of agriculture to the subjects taught. My reason for coming to this conclusion is, that in the present state of agricultural knowledge in India I much doubt whether there is adequate teaching power to provide instruction in the various branches of a complete agricultural course, and also whether, in a purely Agricultural College, there would be sufficient employment

for teachers of ability in those departments of science alone which are connected with agriculture. The Madras Agricultural Com-

ment or promotion in Government service, very few indeed of them subsequently engaged in agriculture. The Punjab College of Science, on the other hand, has been successful in attracting students to the branches of science connected with agriculture, and has been fairly successful in securing for its students the necessary training.

designed for them. I am, therefore, decidedly in favour of this latter system, for the present at least, as against the establishment of special Agricultural Colleges. There is not at present a sufficient call for such colleges, and it is not possible as yet to be

possible that in time, perhaps, there will be occasion for one or more Central Colleges of Agriculture, but there will always be a difficulty in finding a central place, more especially as the agriculture of different parts is so varied. For the present I prefer, as I have said, the utilisation of existing Science Colleges and Institutions to the establishment of any fresh one specially for agricultural training.

in great measure, consequent upon what has been noted at Saidapet and elsewhere, viz., that the aim of the students is not to study agriculture for its own sake, but for the sake of getting Government employ or preferment. It is of course, unfortunate that this is so, and especially that it is not merely a tendency, but an almost universal rule. I do not think that there is much likelihood of a change, and therefore it is necessary to provide for things as we find them.

It will be long, I think, before we shall have any workers in pure science who will devote themselves to agriculture. If a lower ideal has to be taken, it is nevertheless desirable to ensure, as far as possible, that the training shall be that which is most likely to be of benefit to the men in the spheres which they will subsequently occupy. It would be a waste of time to train the men who, later on, become Land Revenue Officers, in pure science.

Even if they do make agriculture the main object, and study

agriculture in an academic way, it is more likely to be productive of good in the end than if they had followed a purely literary course. To take a single instance—in Bombay the higher class of Revenue officers, such as the *Tahsildars* and *Amildars*, are invested with considerable influence in the distribution of advances for agricultural improvement (*taaccavi** advances), and in the management of local funds. It is obvious that a man of this class who has had a good training in agriculture is very much more likely to use that influence wisely, and to understand the agricultural requirements of his district better than one who has had merely a literary training. . . . officials only, for it would . . . not go into Government . . . e fitted with

a training which they could turn at any time to practical account, viz., in the business of agriculture itself, whereas a classical or literary education would not so qualify them.

I fear that one must not look for any great change in the aims of students at Colleges and Institutions, therefore, a greater endeavour should be made to render the Institutions of as practically useful a nature as possible. Seeing, too, the demand that there is for the employment of officers in the Revenue Department, and that they are brought into close contact with the cultivating classes, I consider that the call for the introduction of agriculture into the educational system has been amply justified.

Recognition of
Agriculture by
Universities

507 The next point is, in what form a University may give recognition to the study of agriculture. At Bombay the efforts to obtain a Degree in Agriculture were not completely successful, and a Diploma was granted instead. But, undoubtedly, a diploma will never be considered as carrying the same weight as a degree, and this will certainly militate against the pursuit of agriculture as a study. A diploma is a sort of half-way house, better than nothing, but not the equal of a degree. I do not think that it is satisfactory, and I do not see why a University degree might not be given for Agriculture just as much, for instance, as for Engineering. I

A degree
desirable

. . . agriculture
Universities
seeing how
a stimulus to
the study of agriculture which a mere diploma would fail to pro-
.. .. should
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e con-
nected with it, such as botany, chemistry, geology and physics, but I propose that after successfully qualifying in these branches by the earlier examinations, a student should be at liberty to take up agriculture as an optional subject in the final course for a degree.

The training at
Colleges must be
practical as well
as theoretical.

508. Returning to Colleges, it is not sufficient to give merely a theoretical training in agriculture, but the instruction should be accompanied by practical illustration. This can be accomplished

by having a *Demonstration Farm* attached to the College, where the students may see the actual operations of husbandry, and the cultivation of the different crops carried out. They should also be taught to do the work on the farm themselves, or have a piece of land which they can cultivate with their own hands. This may be sufficient for a College career or for a University degree, but more is needed before a man can be turned out from a College, and be fitted to manage a farm of any size or to superintend an estate. It is in respect of the opportunities which it offers of seeing practical work on a large scale that a Government Farm like Bhilgaon can be of great use, and it would be well to make it a condition that passed students of Poona or similar Colleges should not be promoted to the management of a farm or estate until they have spent some time in practical work on a farm like that at Bhilgaon. The complaints of landowners, that they cannot get competent superintendents, would in great measure be remedied by a provision of this kind, and it would prevent men from leaving the different Colleges with nothing but a theoretical knowledge of agriculture.

509 Passing from Colleges to High Schools, we have to consider the Agricultural Classes which, in the absence of any special College, have been established in several parts of India, and which are as a rule, attached to the High Schools. Those which I visited were at Nagpur, Belgaum and Nadiad. With the first named I was particularly pleased, and I am confident that it is doing decided good. It is quite true that here, as elsewhere, the prominent idea among the students is to get into Government employ, but it must also be remembered that in the Central Provinces there is a steady demand for men who are to be employed in the Land Revenue and Settlement Departments, and it is certainly far better that the appointments should be filled up by those who have had

Agricultural
Classes attached
to High Schools.

Nagpur

possibly, acquired
have followed
likely to under-
stand the condition of the people, their wants, and the ways in which agricultural improvement may be effected. I was very much pleased to see that to do the work of that, in addition, entirely himself,

devoted to experimental work it may be a further advantage, but all depends upon the superintendence available. Of 17 students in the Nagpur Class during 1899-90, 14 passed well and obtained appointments as Revenue Inspectors.

It is worthy of note agricultural education elementary nature, the ent for its teaching por

Principal and his two Assistants being passed students of that institution.

Nadiad.

At Nadiad the Agricultural Class is attached to the High School, and the farm of seven acres is utilised for it. The teachers must have passed at the Poona College of Science. Agricultural Classes are likewise attached to nine of the principal High Schools in Bombay. Each of these is under an instructor who has qualified either at Poona or at Saidapet, and who reports to the Poona College. The examination papers are set from Poona College, and passed students are qualified to join the College.

Belgaum

At Belgaum also, the Agricultural Class is attached to the High School, and a farm of seven acres is utilised for it. The teachers must have passed at the Poona College of Science. Agricultural Classes are likewise attached to nine of the principal High Schools in Bombay. Each of these is under an instructor who has qualified either at Poona or at Saidapet, and who reports to the Poona College. The examination papers are set from Poona College, and passed students are qualified to join the College.

Value of Poona College for supplying teachers.

The above instances show, if proof were needed, how necessary it is to maintain the agricultural teaching at the Poona College in a high state of efficiency.

High Schools.

510. At High Schools more attention should be paid to the study of physical science, and the instruction should also be made more distinctly agricultural in its bearing than is the case at present. Although there may not be the necessity which exists in the case of Agricultural Classes and Colleges, for having farms on which the scholars of High Schools may work, it is very desirable that there should be what I may best term *Illustration Farms*, on which the scholars may see the principal crops cultivated in the district, and have illustrated to them in this way the lessons which they are taught. Illustration Farms of this kind will help to bring home the instruction given and to give point and interest to it.

Illustration Farms

Middle Schools.

511. In Middle Schools the elements of physical science should be taught, and it would be well, too, were more attention given to drawing. I noticed, when present at an examination at the Forest School, Dehra, a great lack of power on the part of the students to represent by means of a figure any object about which they were speaking. If drawing were more extensively taught at these schools, it would be a considerable gain. It is also reduced in Middle Schools by the introduction of the microscope, so also might elementary botany and physiology. There is no call for farms in connection with these schools, but there might be a few *Illustration Plots*, where some of the principal field crops could be grown on a small scale, just for the purpose of illustrating the lessons. In the Central Provinces a scheme is on foot to establish School Gardens, on which the boys may work, and be allowed, as an encouragement, to keep the crop proceeds themselves.

Drawing

Illustration Plots

School Gardens.

Primary Schools. Agricultural "readers," and object lessons.

512. At Primary Schools the most that can well be done in the way of agricultural education is to supply the children with "readers," and object lessons.

quickly comprehended by the youthful mind as the common every-day objects which he had seen around him, and none will be more familiar to him than those connected with agriculture. Sir Edward Buck remarked at the Simla Agricultural Conference that he had often watched the country visitors in the Indian Museum at Calcutta, and that there was no show-case that attracted so much attention as those which contained clay models illustrating the simple agricultural operations in a village. It is the familiarity of the subject which attracts, and so it will be found in primary education, for no illustrations are so apt as those drawn from the every-day life of those who come to receive instruction.

513. There remains but one other class of schools of which I shall speak, the Normal Schools for teachers. The teachers cannot all go through a special training in agriculture, seeing that agriculture is but one of several subjects which they will have to teach, but it is very desirable, and, indeed, necessary, that they should receive sufficient instruction in it themselves to be able to understand and to intelligently teach out of an agricultural text-book. To merely teach agricultural principles as a lesson to be committed to memory, but not to comprehend what the words mean, is utterly useless. Therefore, there should be some provision for the special instruction of teachers in agriculture, whereby they may obtain sufficient knowledge of the subject to enable them to teach it to their scholars. At Nagpur, arrangements have been made for a special Class for teachers in connection with the Agricultural Class held there, and probably similar arrangements could be made elsewhere for the instruction of the teachers of Primary Schools. In some parts, the Central Provinces for example, peripatetic lecturers have been engaged to go from place to place, and to hold classes specially for this purpose, but the

Normal Schools
for teachers.

high class will be needed, there is not much to be expected so far as those now actually engaged in farming are concerned, but that it will be in the

514. A manifest need is the issue of Agricultural Text-books. A few of these do already exist. "Agricultural Primer," original provinces, and subsequently

The need of
Agricultural
Text-books.

re-written and adapted to the Central Provinces, upon Mr Fuller's transference to the latter. This little book is simply and admirably written, and in its 100 small pages it contains a mass of useful information set out in quite an elementary way. The Primer has been translated into Hindi, Mahratti, and Uriya.

More recently, an agricultural Text-book, suited specially to Southern India, has been prepared by Mr C Benson, Assistant Director of Land Records and Agriculture Madras, and Mr C Subba Row, the Sub-Assistant Director. One or two other Text-books or Primers have also been issued by native agriculturists.

But very much more is needed than a text book here and there. The conditions of agriculture are so diversified that any such book, if it is to keep its elementary nature, can be applicable only to quite a limited area. As Mr Fuller says in his preface,—when he came to revise his North West Primer and to adapt it to the Central Provinces, he had to re-write fully two thirds of it, and he adds that not *one* book for the whole of the Central Provinces, but at least one for *each* of its divisions, is needed. The same is true for any other Province of India and thus there is urgent call for simple but reliable and applicable text-books upon agriculture. I look to the appointment of "agricultural experts" and the co-operation of a "scientific adviser" as likely to help greatly in this necessary and important work.

Language is a difficulty in the spread of education

515 One of the difficulties in the way of spreading education is, undoubtedly, *language* or rather the multiplicity of languages. I noticed this when I was at the Forest School at Dehra, during the holding of an examination there. In the higher Classes instruction is given in English, but the teaching is in the vernacular (Hindustani) for the lower Classes. The answers given by the pupils in the vernacular Classes were brought out with far more readiness than by the senior students, and it was often hard to make out whether the latter did not know the answers or whether they merely did not understand the questions.

It will be just the same with text-books. A text book in English will not be understood like one in the vernacular, and it is far more likely to be learnt off as a lesson and committed to memory. Even in one and the same Province several different languages and dialects will be spoken and the text book will have to be translated into each. At the present time there are in use in Colleges in India books such as Wrightson's "Principles of Agricultural Practice," Warrington's "Chemistry of the Farm," Johnston and Cameron's "Agricultural Chemistry and Geology," all of them capital books in their proper application, but not at all intended to meet the special case of Indian agriculture and indeed even calculated to mislead the Indian student in many important points. Where the differences in agricultural practice between England and India are so great, dependence ought not to be put on English text books only but India should supply its own. That this has been done to so small an extent in the past is a proof of the need of paying more attention to the furthering of agricultural education.

Vernacular text books.

516 I have spoken in Chapter XVII, (paragraph 423) of the teaching of agricultural chemistry as a special subject, and have expressed my belief that, though useful as an adjunct, I do not anticipate any great results to follow immediately from it. Nevertheless, it is a subject which should quite rightly enter into a regular agricultural course, such as is given at Saidapet or at the Poona College, or into that of the Forest School at Dehra

Teaching of
agricultural
chemistry

517 The relation of the proposed "scientific" adviser to the conduct of agricultural education throughout the country has also been spoken of in Chapter XVII (paragraph 428), and was dwelt upon at considerable length by the Simla Agricultural Conference. I do not think that, if a "scientific adviser" be appointed, his connection with education can be anything more than of a very general nature. Certainly he can never exercise any control over education, or prescribe on what lines it is to run. The most he can do it seems to me is to generally watch its progress and, possibly to throw out suggestions for its improvement, but more he can hardly do, even had he time for it which he most certainly would not have. Again, it would be inadvisable to have any conflict of authority between the Agricultural and the Educational Departments and on this account, too, I think that the "scientific adviser" could do little more than express his opinion when asked or make, as occasion permitted some suggestions as to the line which agricultural education should take.

Relation of
scientific
adviser to
agricultural
education

518 The question next arises granted that there is a need of men more agriculturally trained, what inducements are to be given to them to pursue the study of agriculture? If young men go to other employments because there are no openings for them in agriculture, how are these openings to be made? Only by giving as good "prizes" for agriculture as for the Bar or for Government employ. The Land Revenue Administration needs a regular supply of men to fill posts in it, Land Revenue Inspectors are required whose business is with the people in their agricultural relations, and who have to do with the soil and the crops. Surely those best fitted are the ones who have had an agricultural training, and the administration of matters concerned with the land will be best carried out by the men who understand agriculture best. In England a land steward is not a man who is taken out of a bank, or who has done no more than take a high University degree in classics or mathematics. So should it be with Land Revenue Inspectors, they should be men who have passed through the Agricultural Classes, or through Institutions that give a training in agriculture. In the course of my tour I met many Inspectors whose mind seemed to be quite a blank on the subject of agriculture, in other parts, as in some districts of the Central Provinces, I found them to take a decided interest in agriculture. These latter were men who had passed through Mr Fuller's Agricultural Class. In Bombay it is now provided that all candidates for the staff of Inspectors of Village Records must qualify by passing a course in agriculture.

I cannot put these views into better general terms than those adopted in the following two Resolutions adopted at the Simla Agricultural Conference, in October 1890 —

RESOLUTION " —
Scientific Agriculture should be a part of the Education of men trained in Law, Arts, and Engineering

and cognate Departments
trained in Law, Arts,

RESOLUTION VII — That where appointments in the Revenue or cognate Departments are made as the result of competitive examinations, Scientific Agriculture should be included as an optional or necessary subject in the examination course

Forest students

The Forest Department has for some time past felt the necessity of having better-educated men to occupy the post of Sub-Assistant Conservator. Efforts are now being made to effect an improvement in this direction, and the introduction of a more agricultural education among these men would qualify them better for their work

Patwaris

Lastly, as regards the hereditary class of keepers of Village Records (*patwaris*), it would be a clear advantage if these men, whose office passes on, as a rule, from father to son, were in their early life to receive a training in the principles of agriculture, and also in drawing instead of having, as is now the case, to be formed into special Classes later on in order to learn their particular work

Classes of Natives for whom agricultural education is needed

519 It may be desirable here to summarise the different classes of Natives for whom agricultural education should be specially provided

- (1) "Experts" of the Agricultural Department.
- (2) Subordinate officials of the Land Revenue, Settlement, Forest, or cognate Departments.
- (3) Teachers of agriculture in High Schools
- (4) Teachers of Middle and Primary Schools where the elements of agriculture are taught.
- (5) The youth of the cultivating classes
- (6) Non-official landed proprietors (*zamindars*, etc)

Agricultural College and other Institutions which I visited.

520 It now remains for me to note briefly upon the Agricultural College, Classes, and other Institutions which I visited.

To take, first, the Poona College of Science, so far as its agricultural course is concerned

Verma's test book.

This college in its agricultural branch is virtually the Agricultural College of the Presidency, and those who have had anything to do with it know how fully its success has been the outcome of the devotion of its energetic principal Dr. Theodore Cook. Successive Governors of Bombay and more recently Lord Reay have also interested themselves greatly in it. I have lately written numerous references to it and have shown what a large amount the differential teaching already given throughout the country owes its are so great. The College has the advantage of being affiliated to the only but Indian the latter giving a diploma in agriculture. The students next to the farm attached to the College, and are lodged so small an extending on it every day. The course is a three attention to the ent of Government Farms in Bombay

teaches agriculture for two months in the year here. In the first year mathe-
 matics is taken up; in the second year, systematic and unsystematic
 zoology, natural science, and surveying, veteri-

would be quite early enough to take up veterinary work

What I should suggest would be—

First Year's Course

Mathematics

Physics

Elementary Chemistry

Elementary Botany.

Elementary Geology.

Second Year's Course

Chemistry (Theoretical
 and Practical)

Biology.

Drawing

Agriculture.

Third Year's Course

Agricultural Chemistry
 Agriculture.

Surveying

Veterinary Science

has been
 job as
 inures
 na of
 ments
 where
 sub-
 ch as

The principal requisite for the Poona course is, to my mind, to make pro-
 vision that the students have more acquaintance with the practical side of
 agriculture, either by themselves working upon the farm, or by having a
 portion of land which they may cultivate themselves, or else by spending a
 certain time upon the large farm at Bhadgaon. Certainly, too, before men pass
 out from Poona to take charge of estates, they ought to have previously
 qualified by a residence at the Bhadgaon or similar farm.

Attached to the Poona College is a Veterinary Hospital, where animals are
 treated.

521. At Baroda great advances have been made lately in the development of agricultural education, and the Gaekwar has shown great interest in the subject. Baroda College.

An agricultural branch of the Baroda College has been formed, and is
 affiliated to the University of Bombay for the diploma in agriculture.

A syllabus should not be framed so as to be far above the heads of the pupils, and appal them with the array of all that they have to get up for it, but it should be set so as to be an index of the requirements which the education given could fairly supply.

The main point to determine with regard to the Sandapet College is, I

524 The Central Provinces do not possess any Agricultural College, or even Science College where agriculture is made a special part of the instruction. The nearest approach to this is the Agricultural Class at Nagpur, of which I have already spoken favourably.

At the time of my visit there were 29 students, 10 of whom were from Nagpur Agricultural Class and most of the others from other parts of the Province. There is a decided want of agricultural instruction in the Educational Department. The Nagpur Agricultural Class had obtained positions as Land Revenue Inspectors.

in it

A certain number of the scholarships of the Educational Department are tenable at the Agricultural Class, the course extending over two years. The teaching agency is entirely supplied from the Poona College of Science.

I thought the arrangement of subjects taught, and also the syllabus, very satisfactory indeed, there were no superfluous subjects, and all of them had a direct bearing upon the principal subject, agriculture. They comprised agriculture, elementary chemistry, botany, geology, elementary veterinary

at Nagpur illustrates the difficulty which language presents to the spread of agricultural education. So far, teaching has been given only in English and with English text-books, but arrangements are being made to have a vernacular Class also.

525. Bengal possesses no Agricultural Colleges, or educational Institutions where agriculture is specially taught. Bengal Instead of this, it had been at one time the practice to send selected Natives to England to study agriculture at the Cirencester College. This has, however, now been abandoned. In place of it, it is proposed to have an agricultural branch at the Seebpore College of Engineering, near Calcutta, and to utilise the Seebpore Experimental Farm which adjoins the College.

In the North-West Provinces there is no Agricultural College, North-West nor special provision for the teaching of agriculture. Provinces.

Mr. T. H. Middleton, who passed a distinguished career as a student at Edinburgh University and elsewhere, has been appointed Professor of Agriculture, and has been in charge of the Agricultural Department of the Government of India, his guidance. The students of the Poona College of Science and Arts, Poona, are under the guidance of the Presidency.

522. The other Bombay Agricultural Institutions which I visited were the farms, or rather fields, in connection with the Agricultural Classes attached to the High Schools at Belgaum and Nadiad. As mentioned a little before, there are Agricultural Classes attached to nine of the High Schools in Bombay.

Belgaum.

At Belgaum, bursaries of Rs 4 per month are paid out of the local funds, and are tenable for three years. The field is seven acres in extent, and the Municipality gives as a grant, School to the better and English-
The teachers must have passed

Nadiad.

At Nadiad the farm of the Agricultural Association is thrown open to the students attending the Agricultural Class of the High School. A museum, with specimens of crop products, implements, etc., is attached.

523. Passing next to Madras, the Saidapet College calls for special attention. Its history has been dealt with in the last chapter (see paragraph 495), and now I have only to remark on what I noticed when I visited the College and Farm.

Saidapet College

Of the unsuitableness of the Saidapet Farm, either as an experimental or even as an educational farm, I have already spoken, and, after having seen it, I am not inclined to regard at all favourably its proposed extension, even as a farm for teaching purposes.

Owing to the constant change of policy pursued by the Madras Government with respect to the College and Farm, these have laboured under considerable difficulties.

given up, with very unsettled
dapt has now which agricult
abundantly cle
course contain
attainment in

etc. Eng
text-book.

There were what seemed to me marked defects about the examination itself, though I believe that these have to some extent been since remedied. Thus, the examinations ought not to be conducted (as they used to be) by the teachers of the school alone, a student, after failing once, should not be allowed to go in for a special examination a short time afterwards and try to pass then; and, thirdly, far too much time was taken up by the examinations. The one that I was present at for a time was fixed to last from March 1st to March 10th, and was held in the morning. Its programme was as follows:—
except
for any
examination is more than enough to ascertain a man's real knowledge of a subject, and I should like to see this supplemented by written periodical examinations. These are points which can readily be remedied, and it is but right that I should say I thought very well of the teaching as a whole. There

CONCLUSIONS

CONCLUSIONS.

527 The spread of education will be an important element in the improvement of agriculture. It will do much to remove the prejudices attaching to "caste" and custom, which prevent progress in agricultural methods, and it will give rise to a more intelligent farming class.

In a country where, as in India, agriculture is the chief employment, Agricultural Education especially should be encouraged. Until lately the tendency of education has been in a purely literary direction, and has turned attention away from the land rather than towards it, the fault can now be best remedied by substituting Agricultural Education for a part of the present educational programme. The work must proceed simultaneously from above downwards and from below upwards. Elementary instruction should be given in Primary Schools by means of "readers" and "object lessons," which introduce familiar agricultural subjects. In Middle Schools the elements of physical science, the use of Agricultural Primers, accompanied by *Illustration Plots* on which the ordinary farm crops are grown, should form part of the instruction. In High Schools more attention should be given to physical science and to agriculture, and *Illustration Farms* or fields should be attached to the Schools. Agricultural Classes should be established where Colleges or Institutions that specially teach agriculture do not exist, and these should have *Demonstration Farms* attached, and land on which the pupils can themselves work.

Special attention should be directed to the agricultural education given in Colleges, in order that the teachers supplied to High Schools and to Agricultural Classes may be well trained men, and that the Land Revenue, Agricultural and cognate Departments may be supplied with subordinate officials who have studied agriculture, both theoretically and practically.

I do not consider it advisable to establish special Agricultural Colleges, but I think that it would be better to utilise existing Colleges of Science and to form agricultural branches at them. Universities should encourage the study of agriculture by making agriculture an optional subject in the course for a degree, and the

claims of men who have passed in agriculture should be fully recognised for appointments in the Revenue and cognate Departments. There is great need of Agricultural Text-books suited to the circumstances of the different parts of India, and these should be in the vernacular as well as in English.

RECOMMENDATIONS

RECOMMENDATIONS

528 That General Education be extended among the agricultural classes

That Agricultural Education form a part of the general educational system, and be introduced as a prominent subject in the Schools of the country

That Text-books on Agriculture, adapted to the different parts of the country, be prepared as early as possible

That encouragement be given to the higher study of Agriculture by recognising more fully the claims of men who have passed in scientific agriculture, for appointments in the Land Revenue and cognate Departments.

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Necessity of
giving more
weight to the
study of Natural
Science

difficulties as to promotion, time of service, pay, etc. But I do endorse most thoroughly those recommendations of the Famine Commissioners, and of the Government of India, which have for their object the giving of more weight to the study of Natural Science. I maintain that what is needed is not so much to have men, or I will say Agricultural Directors especially, who shall be practical agriculturists, but to have men of a scientific turn of mind who have some knowledge of what science has accomplished in the past, and of what it is likely to effect in the future, men who will have some appreciation of scientific work and of workers in science. Now, this can only be gained by an early training in scientific subjects, and, although the details of agricultural practice can be acquired at a later date, the pursuit of scientific methods and their application to practice cannot. I have been much struck in India by the almost complete isolation in ideas of the few men who have gone out to the country possessed of some knowledge and appreciation of natural science. They have, as it were, stood almost alone, unappreciated, or, rather, not understood, by their more classical or mathematical brethren. Yet I can see quite well that, among the men who have done most to help on agriculture, in many cases the impulse has been given by their love and appreciation of natural science. I think that the tendency of modern education to proceed in the direction of a more liberal and scientific training will carry with it important results which will indirectly influence even Indian agriculture and that with the coming of more Civilians to India who have had a certain amount of training in natural science, a class of men will be obtained whose presence will aid the improvement of agriculture by making the application of scientific methods more easy, and better appreciated.

I think, accordingly, that the giving of more prominence to scientific subjects, both at the open competition and at the later examinations for the Civil Service, would be attended with decided benefit, and that from the men who have distinguished themselves in this branch some might be selected who would subsequently prove useful officers in the Agricultural Department.

Agricultural
chemistry at the
final examina-
tion

532 As to agricultural chemistry, now an optional subject at the final examination, although I am, as an examiner myself, obliged to allow that many candidates take up the subject purely with the view of swelling the total of the marks that may stand opposite their names. I have every year, so far, found some few men who have shown more than a passing interest in it and who, if opportunity were given them of subsequently turning their attention in an agricultural direction, would, undoubtedly, be able to derive and to impart benefit from their study of agricultural chemical principles. It is men such as these who should be noted when they have done well, and it is from them that the future Agricultural Directors might advantageously be selected.

Employment of
junior Civilians
in Department
of Land Revenue
and Agriculture

533 But it is not enough to merely note such men, it is necessary, too, that they should, as a rule in India, be brought into contact with agriculture and its conditions, and be encouraged to study it in its varied relations.

It is universally acknowledged that a young man on his first coming out to India is, in point broadly, of very little use. He cannot be entrusted with any post until he has got to know something of the language, the people, and the district where he is. As a Collector of experience told me, "the best thing is to send the new comers out into the fields for four months or so and then they may begin to pick up something." If, on the other hand, they are left to gather their experience in the court-house (*cuteherry*) they soon lose the little agricultural knowledge they had, and never get to understand thoroughly the conditions of the people and of their agriculture.

It would be well, therefore, that when men come fresh to the country, a certain proportion should be drafted into the Depart-

had some insight into the circumstances which call for their creation? At the same time, these junior Civilians might be in-

At the departmental

Departmental examinations in agriculture.

are examined upon the district where they happen to be fixed; but why should they not be examined upon the local agriculture also? I think that this would be one of the best ways of picking out the men who showed an interest in agriculture, and who gave promise of being able to deal well with it. If Agricultural Directors were selected from men who had undergone some training of this kind, instead of being chosen (as at present) without any or with very little regard to their agricultural knowledge or powers, it would be very much better for agriculture.

It would also be a useful stimulus to these men if encouragement were given them to study agriculture in other countries when absent upon furlough.

Encouragement to study agriculture when absent upon furlough.

534. It is not only in the method of selecting Directors of Agricultural Departments that a better system should prevail, but it appears to me that there should be some alteration as regards the position which a Director occupies, and chiefly in his relation to the existing Revenue Administration. At present the description I have heard applied to the Director that of being a "fifth wheel of the coach" is very near the truth. He has no administrative powers, and can only act as an adviser; he has not even the power of fixing or determining the agricultural conditions in the district.

The position of Directors of Agricultural Departments

It is very certain that in different Provinces different circumstances will prevail, and hence it may not be possible, and indeed would

not be wise, to give the Director of the Department of Land Records and Agriculture the same position everywhere alike. Nor can his duties be everywhere the same. He must, in brief, be made to fit into the existing Revenue organisation in each Province, and be put where he will go best. He should form a part of the Revenue Administration, and not have his duties confined merely to the giving of advice. As I pointed out earlier (Chapter VI, paragraph 113), he should have a large share in the management of *taccari* advances for the purpose of digging wells, etc., even if the actual control and disbursement cannot be left in his hands. Again, he should have the power of making representations, as to the giving, in special cases, of exemption from assessment, and of reporting upon instances of over-assessment. As regards other Revenue officials, a Director ought to stand higher than he does at present. The post is one that should be occupied by a moderately senior man ranking with the highest grade of Collector, but a little below a Commissioner. I would much prefer to see the title "Commissioner of Agriculture" given to him instead of the present one, as the title would more adequately describe his duties and define his position.

Commissioner of
Agriculture

The need of
touring

535 The desirability of an Agricultural Director's spending a considerable time each year in touring should be self evident, and yet there are Provinces in India where the Director does not go on tour at all, or where very little touring is done. To get by personal enquiry and observation a knowledge of the agricultural requirements of a district, whether as regards water supply, wood supply, cattle, seed, or the incidence of assessment, is of the very nature of a Director's duties, and how he is to discharge these properly without going about in the districts of his Province I fail to see. If this part of the work be given up, it is little to be wondered at that the Director will leave out agriculture from his title and confine himself to Land Records.

The Secretary of
the Imperial
Agricultural
Department.

536 The above remark applies in a special manner to the Secretary of the Imperial Agricultural Department. With numerous duties and a large staff, on all of which he cannot be an expert, the Department must rely upon others. It is well, therefore, that he should be brought from time to time into touch with the officers of the Provincial Departments. There will frequently arise matters which call for personal inspection, or, it may be, for personal explanation, and the experience of a Secretary who has knowledge of what has been done in other Provinces may often be of much use in guiding the counsels of Provincial Departments. Without unduly forcing upon a Provincial Department any particular line of action in individual cases, it is well that there should be uniformity of purpose, and the same guidance. The Imperial Department would be of common use with the Provincial Departments, which would fall to the lot of an Inspector General.

While on this subject, I might add a word expressive of my belief in the usefulness of occasional Conferences, for the purpose

Simla, in October 1890, impressed this very clearly upon me, and I have to acknowledge much benefit and information which I derived from the interchange of views by representatives coming from different parts of the country, who in this way brought their experience to bear upon the particular points set for consideration.

537. The Department should be made.

These are as follows:—

- I. Organisation and Maintenance of Village Records.
- II. Analysis of Districts with reference to security from Famine.
- III. System of Collection of Revenue and Rental in precarious Tracts.
- IV. Measures of Protection against Famine.
- V. Agricultural Experiments, including Farms.
- VI. Cattle-breeding and Veterinary Establishments.
- VII. Agricultural and Fiscal Statistics.
- VIII. Trade and Trade Statistics.
- IX. Museums, etc.
- X. General.

Most of these subjects have already been dealt with in this Report, while others, such as Statistical Records, are not connected with my special work. It will not be necessary to touch upon a few general points not already noticed, and to mention special features of the work of individual Provincial Departments.

538. I frequently had the opportunity of visiting the Village Records, and of seeing the work of the Land Records Department. I was very clear to me that a great deal of care had been given to the perfecting of the work of Land Records, and to the training of the men to whom the keeping up of these is entrusted.

The one matter in which there seemed to me to be a lack was, that the statistics obtained, say, for individual fields or holdings, need to be collected together and to be then digested. The main points brought out by the figures require translation into words, so that useful general conclusions may be drawn from them.

Thus, it is not enough to have a record of the area of a particular crop. One wants

Then, there are apparent discrepancies which need explanation, and general results ought to be collected for each district. The real requisite is, it seems to me, a central Bureau of Agriculture, where the returns would be gathered together, examined, digested, and put in a handy form for general use. Something similar to the useful work done by Mr. J. E. O'Connor for the Trade of India should be instituted in connection with its Agriculture.

In Bengal, in consequence of the existence of a permanent settlement, there are no Village Records, except those relating to Government and private Estates. These Estates cover altogether about 20,000 square miles. There is, consequently, no regular *patwari* staff. When speaking of indigo cultivation in Behar I mentioned the difficulties which arise in consequence of there being no Record of Rights, from what I could see I should be strongly of opinion that the Cadastral Survey of Behar, which it is intended to set on foot shortly, will be productive of immense benefit, in that it will put an end to the troubles that have arisen from the absence of any Records defining and demarcating the different holdings and occupation rights.

Analysis of
districts.

539 The Analysis of districts is a most important work, and one which in many cases has been well done. But it has, so far, had reference mainly to the question of security against famine, what is now needed is, that there should be an analysis of districts with regard to their general agricultural capacity and condition. In such work the employment of trained "experts" will be very necessary.

Bombay

The most elaborate work as yet done in the analysis of districts has been the compilation of the "Statistical Atlas of Bombay." This atlas comprises an immense amount of information and statistics respecting the agriculture of the different districts of the Bombay Presidency.

North West
Provinces and
Oudh

In the North-West Provinces and Oudh the Annual Reports of the Department give, from time to time, statistical maps showing the distribution of different crops throughout these Provinces.

Madras

The Madras Government has also published a series of maps showing the distribution of different crops throughout the Madras Presidency.

Central
Provinces

Punjab

valuable "Manual of Coimbatore," by Mr. F. A. Nicholson, of which I have made copious use in this Report.

Nothing has yet been done in this direction in the Central Provinces or in the Punjab, beyond what is contained in different Settlement Reports.

Bengal

In Bengal, however, a few districts have been specially reported upon, notably the Dacca District by Mr. Sen, and the Icharda District by Mr. Basu. I have read both of these Reports.

with considerable interest, and I think it would be a great advantage if the work were continued successively for the different districts throughout the Presidency.

540. Under "Measures of Protection" are included the establishment of "Fuel and Fodder Reserves;" the formation of plantations along canal banks and railway lines, arboriculture; irrigation; *taccari* advances for digging wells, and for other purposes; reclamation of ravine and salty land (*usar*); embanking of land; emigration, etc. Sufficient has already been said under each of these headings.

541. Under "Agricultural Shows" are included the establishment of "Fairs, Farms," etc. These call for Agricultural Shows. The North-West Provinces have been universally successful, and in several instances it has been decided to give up Shows which were formerly held regularly. The non-success has been, perhaps, most marked in Madras, and what appears to me the chief reason of failure is, that the Shows have merely been held, that they are not interesting. During my tours I had the opportunity of visiting two or three Agricultural Shows, and I was much struck by the differences between them, even in the case of districts not very far apart. Thus, the first one I went to, viz., that at Saharanpur, though it was interesting in some respects, compared very badly, alike in the exhibits and in the interest taken, with the Show held a little later on at Meerut (Nauchandi Fair). I put this down mainly to the lack of local interest taken in the former, and to the little encouragement given by the English officials. In short, I believe that the success of a Show depends in great measure upon the efforts of the individual Collector or other resident officer, and that he has it largely in his power to make the Show a success or the reverse. Where, as I found to be the case in Madras, a Show was held mainly because the Government had decided that there should be one, it is not to be wondered at that the interest aroused was small. At Saharanpur no effort appeared to have been made to foster local industries, and the exhibition of local work was very inferior, at Meerut, on the contrary, the exact reverse was the case, and an admirable collection of the results of native and local talent was to be seen. Turning to the more agricultural side, I must say that I was quite surprised to see at Meerut a Show which would by some of our cattle experts, matches, trials of water-lifts, the working of the "cream-separator,"

Measures of Protection

Agricultural Shows

Success depends on individual efforts.

Exhibition of local industries

Horse show good.

At the Meerut Show I noticed particularly the horse ring. It

was admirably constructed, and quite picturesque with its enclosure of bamboo fencing topped with straw. The arrangements for the entry and exit of the horses, and for sending them round the ring, as also for the judging, were capital.

In some matters I would venture to suggest possible improvements.

Definite fixtures

I have seen it mentioned that in some cases the dates on which Shows are to be held are not fixed long enough ahead, and are altered after they have been once fixed, also that they are not sufficiently advertised. Both of these points must militate against the success of a Show. The fixtures ought to be made well ahead, and the dates be rigorously kept to, so that the Provincial Agricultural Department can issue, in advance, a list of the Show fixtures for the whole year. If dates are changed or if fixtures are left uncertain, people are sure to lose interest, and it also prevents proper advertisement being given to a meeting. The notices of the Show should be in the vernacular, and the more widely distributed they are the better.

Good advertisement

Annual Provincial Show

It is well worth considering whether it would not be a good plan to follow the plan adopted by the Royal Agricultural Society of England, and to have one Great Show annually in a Province (the *locale* being changed from year to year), this taking in turn the place of the ordinary local Show held in any particular district. To this Show the Government subsidy might be confined, and a regular *rota* being determined upon, each district would be visited in turn and more outside interest be aroused.

Practical judges

Next, every effort should be made to get good practical judges

It is, I know, the practice always to turn to the Collector, or to the Director of the Agricultural Department, but it does not at all follow that they are the best agricultural judges.

System of judging at Horse Shows

In the awarding of prizes for horses, I noticed that as many as five judges are frequently appointed, one judge taking into account, strength, another judge, quality, a third, soundness, and so on, 20 points may be awarded for each item, and the decision is given according to the highest total found on adding up the marks which each judge awards in his particular section. There is, however, no separate veterinary examination. I very much doubt whether it is in the power of any judge to examine and to allot exact marks for one individual quality possessed by a horse, apart from the others which it has, it is rather by a setting off of one against the other that a judge should base his award. Besides, the difference of standard necessarily adopted when as many as five judges officiate at once, introduces errors which, I believe, are greater than the advantages gained by collecting the opinions of several different judges. As a consequence, on looking into the figures when made up to a maximum of 100, I found that the differences, even with this large number of marks, were generally very small and it was seldom that as much as 20 marks separated the best from the worst horse in a class, although the judges allowed to me that the real differences amounted to very much

more; and so, too, it proved, for, in the not infrequent case of a "tie" occurring, the judges, without hesitation, expressed their decided preference for one animal over another, although the totals of the marks obtained on the individual system of judging were equal. There should, I think, be a veterinary examination of the horses, and unsoundness ought to *disqualify* and not merely to *reduce* the marks awarded.

A Horse Show loses plan generally adopted forming practically a plan arranged in classes, and being put side by side so that they can be compared. I was told that this arises from the fact of one man being in charge, possibly, of a number of different horses, and not being able to attend entirely to one, still it is a defect.

Another want in connection with Agricultural Shows is that of a Catalogue. The issue of a catalogue with corresponding numbers on the exhibits would much add to the interest taken

From what I saw of poultry exhibited at Shows, I thought that very considerable improvement might be effected if more attention

The open to g are allow

that the specimen is at all representative of the crop from which it is supposed to have come. It is quite easy to pick over by hand a sample of wheat or other grain and to make it look excellent. But there is not any certainty that the sample exhibited has come off the field of the particular exhibitor. If prizes are awarded for grain

corn it respon is, th the he

This would do a great deal more than grain prizes in stimulating improvement, and would be free from the objections to the latter.

In regard to the exhibitors themselves, more care should be exercised in order to ascertain that they are *bona fide* exhibitors and cultivators. There is little doubt that in many cases men have made it a regular business to "farm" the prizes offered, by the aid of some particular exhibit of which they have obtained the use, though they may not be the genuine owners or exhibitors. Such abuse must have the effect of keeping the genuine cultivators from exhibiting at Shows

The last point to which I shall refer in this connection is the trial of implements.

Without doubt, a considerable amount of interest is aroused by competitions of this kind on Show grounds, but I am afraid that they are not always carried out with sufficient care, and it would be much more satisfactory if more exhaustive trials were conducted at Experimental Farms. The latter are the places where such trials can best be made, and in the case of new implements, they should be submitted to rigorous tests before the *imprimatur*

Horse fair.

Catalogue

Poultry at Shows.

Prizes for grain samples

Farm prizes preferable

Bona fide of exhibitors.

Trials of implements

Agricultural
Departments
could not
compete with
purchased
implements

of the Agricultural Department is placed upon them. Again, it is the general practice for Provincial Agricultural Departments to exhibit at the various Shows, and to enter for competitive trial a number of implements of different makes which have been purchased by the Department. This appears to me hardly fair upon the makers or inventors of the implements, for the success or non-success depends very much upon the particular implement which the Department happens to have, the time at which it was purchased, and the way in which it has been kept and used. Thus, a sugar-mill of a particular make, which the Department has bought some years previously, and has probably used also in the meantime, may be brought into competition with a brand-new machine exhibited by some rival maker. If there are to be these competitions, the credit of the makers should not be dependent upon a machine exhibited by someone other than themselves, but they should have the opportunity of being represented by the latest and very best machine which they can turn out at the time, after that, in the event of failure, they would not have any reason to complain that they have not been fairly represented.

I notice that one year, in a competitive trial of sugar mills at Saharanpur, the number of points awarded to a mill exhibited by the makers themselves was 88, while one of a different make and exhibited by the Agricultural Department had 87 points given to it. Such minute distinctions as these, under the conditions of a rough trial, ought not to be drawn, and the fame of one firm should not be made at the expense of another, when there is no practical difference between rival exhibits and more especially when one firm is represented by a new machine, and the other by one probably of earlier date. I think, to confine them selves to implements brought under their notice.

Shows in
Bombay

In the Bombay Presidency some six different Shows are held annually, the annual Government contribution to them being about Rs 8,000. The Horse Fairs at Poona, Ahmedabad, and Sind are the best known Shows, the last named being generally very successful.

North West
Provinces and
Oudh

In the North-West Provinces and Oudh the chief Shows are those at Aligarh, Meerut, Saharanpur, Etawah, and Muttra. Government awards over Rs 1,000 annually for cattle prizes in connection with these Shows the services of Mir Muhammad Husain, the Assistant Director of Agriculture, are invaluable, and to his energy their success is in large measure due.

Madras

In Madras the chief Shows are those at Bellary and at Salem.

Bengal

In Bengal occasional Shows are held at about five different towns.

Purchase of
horses by Army
Remount De-
partment

At the different Shows held throughout the country a stimulus is given to Horse-breeding by the purchase of young stock for the Army Remount Department, some of the officers of which attend the Shows and buy animals which they think likely to meet

army requirements in the future. Mares are also selected to be "branded" mares, and thus become eligible to be served by Government stallions.

542 Under the head "Experimental Farms" are also classed seed distribution and sale of implements. Cattle breeding, veterinary establishments, etc., which come under the next head, have also been fully referred to before.

Other branches of the work of Agricultural Departments

The other heads under which the work of Agricultural Departments falls do not call for special mention by me.

543 The Organisation of Agricultural Departments of Agriculture in the Punjab, for instance, merely forms a part of the

Organisation of Departments in different Provinces

Land Revenue Administration, its Report being included in the general one of the Administration and not being given under the different heads prescribed by the Government of India.

Punjab

In the Central Provinces there is a Commissioner of Agriculture, who combines with his duties those of Commissioner of Settlements.

Central Provinces

In Madras there was no separate Department until 1882, and the Director is not a travelling one but always remains at headquarters.

Madras

In Bengal there was no separate Department until 1885, and the one then started was established only as a temporary or tentative measure.

Bengal

In the North West Provinces and in Bombay, there are separate and complete organisations.

North West Provinces
Bombay

544 The Agricultural Department has frequently been found fault with on account of the mistakes which it has made, and of the number of minor matters which it has turned its attention to, while neglecting the larger and more pressing questions. It has been pointed out that the Department has exercised itself about the introduction of iron ploughs, of cotton cleaning machines (ginning machinery) and has spent time and money in attempting impossible hybridisations of cotton, whilst it has declined to tackle urgent matters such as the indebtedness of the cultivating classes, the over assessment of the land, and the working of the system of loans for agricultural improvement. It is not for me to defend the Department from such charges, or to say that they have not been justly made, but it is clear to me that the work of the Department has been greatly hindered by three main causes: want of sympathy, imperfect machinery, and want of money. I have attempted to prove that the first should not be any longer shown that the second is capable of improvement, and that, thirdly, the further expenditure of money is an absolute necessity for the accomplishment of any real good.

The future policy and requirements of Agricultural Departments

What line exactly the Department should take up depends entirely upon the machinery with which it is fitted and upon the means placed at its disposal. I have indicated that I consider that one great problem which will have to be met in the immediate

future is the provision of "Fuel and Fodder Reserves," in order to supply wood to take the place of dung as fuel, and so to set free the dung for its proper use as manure to the land. I have also expressed an opinion that a share in the management of loans (*taccavi* system) for digging wells and for other agricultural improvements might with advantage be entrusted to the Agricultural Department, and that the Department should have power to enquire into cases of over assessment, and to recommend exemption from assessment in special cases, in order to encourage the carrying out of agricultural improvements. But such measures cannot be carried out without a more extended machinery than the Department possesses and without its having placed at its disposal considerably larger means than in the past. That a larger expenditure is warranted I fully believe, and I am confident that the outcome will be the bettering of the condition of the agricultural classes, and the increase of revenue to the State.

In conclusion, I would urge once more the need of having uniformity and continuity of policy. In a country like India, where conditions are so diversified, there must of necessity be differences of method in the working out of any policy, and these methods may have to be altered according as the conditions alter. But there should be uniformity of general principle, and one policy alike should characterise the action of Agricultural Departments, both Imperial and Provincial.

CONCLUSIONS

CONCLUSIONS

545 In order that Agricultural Departments may be equipped with the right kind of men to carry out the agricultural improvements which have been suggested in this Report, it is very desirable that more attention should be given to the early training in a scientific direction of future Civil Servants, and that, on their arrival in India, they should have more opportunities of acquainting themselves with the agricultural conditions of the country. This will be best effected by giving more weight to Natural Science at the open competition and at the final examination, and by drafting a certain proportion of the men, on arrival in India into the Department of Land Records and Agriculture. Out of those who have distinguished themselves by their proficiency in science, and subsequently by their interest in agriculture, the future Agricultural Directors might advantageously be selected.

The position of Agricultural Director should be invested with some administrative power, and the granting of loans for agricultural improvements should be in part managed by the Agricultural Departments. Analyses of districts should be made in respect not only of security from famine, but also of general agricultural conditions and requirements.

In order that the work of Agricultural Departments may proceed in the right direction there are two essentials, (1) a more competent machinery, and (2) an increased expenditure of money upon agricultural improvement.

Lastly, there must be uniformity of principle in the action of Imperial and Provincial Agricultural Departments, and a continuity of policy throughout.

RECOMMENDATIONS

RECOMMENDATIONS

546. That more weight be given to Natural Science in the open competitions for the Civil Service, and at the final examination of probationers.

That a certain proportion of junior Civilians, on arrival in India, be drafted into Departments of Land Records and Agriculture.

That Agricultural Directors be chosen from those men who have distinguished themselves in Natural Science, and subsequently by their interest in Agriculture.

APPENDIX.

In the Appendix, analyses of wheat soils from the Sirsa sub-division are given, bringing out the Report in the Report are repeated, and explanatory notes are added where necessary

A. (see Chap. V, paragraphs 58—68.)

Composition of Wheat Soils from the Sirsa sub-division
(Punjab).

(Soils dried at 212° F.)	No. 1. From Ghaggar Bed.	No 2 From Sotar Valley.	No 3 From Gudah.
* Organic Matter and combined Water	63	2 67	65
Oxide of Iron	258	4 92	1 62
Alumina	1 72	5 85	2 02
Carbonate of Lime	2 96	2 57	3 33
Magnesia	1 07	1 97	1 07
Potash	39	74	31
Soda	15	08	11
Phosphoric Acid	17	23	19
Insoluble Silicates and Sand	90 33	81 57	90 70
	100 00	100 00	100 00
* Containing Nitrogen	07	02	trace.
Equal to Ammonia	08	02	trace.

No. 1 is soil from the bed of the Ghaggar, a stream which is crossed on the journey between Halki and Umbhali. In the lower part of the course the bed is sandy. The soil was light-coloured, containing much fine sand with micaceous particles.

No. 2 is soil from the Sotar Valley, which seems to have been formerly the bed of the Ghaggar, the bottom is firm and even heavy soil. It is reckoned to be the best soil in Sirsa. The sample analysed was free from micas, and was not nearly as fine and sandy as No. 1.

No. 3 is a soil called *Bousli*, a name applied in Delhi and the North-West generally to any sandy loam. It is very like No. 1, but is even finer and more sandy.

however, both of vegetable matter and of nitrogen will, I consider, be very necessary in all three cases. Green-manuring, or the use of cattle-dung or similar nitrogenous organic materials, will be the best means of supplying the deficiency.

(For further remarks see Chap V, paragraphs 58—68.)

B. (see Chap. V, paragraphs 68—68.)

Composition of Coffee Soils from Munjerabad, Mysore.

(Soils dried at 212° F)	No 1.	No 2.	No 3
* Organic Matter and combined Water	7 15	13 78	13 30
Protoxide of Iron	trace	1 54	2 54
Peroxide of Iron	5 04	11 83	12 02
Alumina	20 39	11 53	13 81
Lime	20	32	33
Magnesia	23	32	30
Potash	25	10	10
Soda	12	12	09
Phosphoric Acid	13	15	10
Sulphuric Acid	03	02	04
Nitric Acid	—	—	—
Chlorine	01	—	—
Insoluble Silicates and Sand	65 40	60 34	57 39
	100 00	100 00	100 00
* Containing Nitrogen	0 32	20	20
Equal to Ammonia	0 30	24	24

No 1. Hindiganhulla, Ida Munoo, considered good coffee soil

No 2 Barteinhulla, Upper Toddyman's field, where coffee does not do well

No 3 Barteinhulla, Kemp Munoo, from Nui Gondas Hestloo, where coffee does not do well

It is primarily noticeable in these soils, that the soils given in Appendix A, the larger, and that the soils also. On the other hand, there is consider a decided deficiency on taneously practised Potash, etc. Wheat soils, and, for the requi amount does not seem suffici. Manuring with wood ashes, or some other source of potash, would be ben. in all cases Phosphoric acid bones ma the same and alom: soils On: ance in the seem to res. probably a state of pe

(For further remarks see Chap V, paragraphs 63—68, and Chap XIV, paragraph 363)

C. (see Chap. V, paragraph 99.)

Composition of Two Samples of Well Water and Canal Water from Rawatpur, near Cawnpore, taken April 1890.

	Well Water.	Canal Water (Cawnpore Branch of Lower Ganges Canal)
	Grains per gallon	Grains per gallon
Total Solid Residue (at 130° F) .	71 93	15 18
Containing—		
Oxide of Iron and Alumina .	—	28
Lime	7 56	3 36
Magnesia	6 30	1 68
Potash	37	80
Soda	20 53	1 40
Chlorine	9 20	30
Phosphoric Acid	73	06
Nitric Acid	5 50	—
Sulphuric Acid	6 30	1 06
Soluble Silica	1 96	1 26
Free Ammonia	002	001
Albuminoid Ammonia	006	007

Combining the above constituents together in the forms in which they are probably present in the waters, the composition of the samples may be represented as follows —

	Well Water	Canal Water.
	Grains per gallon	Grains per gallon
Carbonate of Lime	4 09	4 55
Carbonate of Magnesia	13 23	3 52
Carbonate of Soda	16 41	2 39
Carbonate of Potash	—	60
Sulphate of Lime	10 71	1 80
Phosphate of Lime	1 59	13
Chloride of Potassium	69	63
Chloride of Sodium	14 69	—
Nitrate of Soda	8 66	—
Oxide of Iron and Alumina	—	28
Soluble Silica	1 96	1 26
Total Solid Constituents	71 93 { grains per gallon	15 16 { grains per gallon.
Free Ammonia	003	001
Albuminoid Ammonia	005	007

(For detailed remarks on the above analyses see Chap. VI, paragraph 99)

D. (*see* Chap. VII, paragraph 121.)

Composition of Indian Cattle-dung.

[Solid Droppings of Cattle.]

	Dung from Lean Cattle (air-dried)	Dung from grain fed Cart (<i>bandy</i>) Bullocks. (air dried)
Moisture	19.09	17.86
* Organic Matter	59.23	61.89
† Mineral Matter (ash)	21.15	20.25
	<hr/> 100.00 <hr/>	<hr/> 100.00 <hr/>
* Containing Nitrogen	1.34	1.03
Equal to Ammonia	1.62	1.31
† Containing		
Insoluble Siliceous Matter	14.43	16.75
Oxide of Iron and Alumina	3.36	1.36
Lime	1.04	.85
Magnesia . . . . .	.44	.30
Potash	1.16	.60
Soda . . . . .	.34	.26
Phosphoric Acid . . . . .	.47	.54
Equal to tribasic Phosphate of Lime	1.03	1.18

(For detailed remarks on above *see* Chap. VII, paragraph 121.)E. (*see* Chap. VII, paragraph 121.)

Composition of Ashes of Indian Cattle-dung, after burning.

Moisture	2.04
* Organic Matter	2.40
Oxide of Iron and Alumina	9.26
† Phosphoric Acid	1.37
Lime	1.76
‡ Alkalies, Magnesia, etc	2.97
Insoluble Siliceous Matter	80.20
	<hr/> 100.00 <hr/>
* Containing Nitrogen . . . . .	.17
Equal to Ammonia . . . . .	.20
† Equal to tribasic Phosphate of Lime	2.93
‡ Containing Potash	2.05

F. (see Chap. VII. paragraph 146.)

Composition of Drainings from Manure heap (*gobra tipi*) taken at Munjerabad, Mysore.

Water and Volatile Matters	97.29	} 2.71 Total Solid Residue.
Non-volatile Organic Matters	1.23	
* Mineral Matter (ash)	1.48	
	<u>100.00</u>	
Total Nitrogen	1.44	
Equal to Ammonia	1.74	
* Containing -		
Silica	31.8	
Oxide of Iron and Alumina	2.48	
Lime	0.75	
Magnesia	0.59	
Potash	4.26	
Soda	0.29	
Phosphoric Acid	0.50	
Equal to tribasic Phosphate of Lime	1.10	
Specific gravity at 60° F.	1.025	

A standard English analysis of Drainings from Manure heaps (Johnston and Cameron's Elements of Agricultural Chemistry and Geology, page 380) gives the following figures -

In 100 Parts	Parts
Total Solid Residue	1.939
Containing Chloride and Carbonate of Potash	5.11
Phosphate of Lime and Iron	1.01
Total Nitrogen	0.44

Thus, the Drainings from the Indian Manure heap were slightly richer than those from the English.

G. (see Chap. VII. paragraph 146.)

Composition of the Urine of Lean Cattle and Grain-fed Cart (bandy) Bullocks.

	Lean Cattle	Cart Bullocks.
Water and Volatile Matters	91.77	90.62
Non-volatile Organic Matters	5.29	7.64
* Mineral Matter (ash)	2.94	1.74
	<u>100.00</u>	<u>100.00</u>
Total Nitrogen	9.56	1.168
Equal to Ammonia	1.161	1.418
* Containing -		
Silica	0.04	0.10
Lime	1.61	0.60
Magnesia	2.49	5.70
Potash	1.628	6.43
Soda	0.00	0.00
Phosphoric Acid	0.22	0.22

(For detailed remarks see Chap. VII. paragraph 146.)

H. (*see* Chap. VII, paragraph 149.)

Composition of Leaves and Twigs used for Litter in Mysore.

	1.	2.	3.
	Leaves	Leaves (mainly <i>Jack-fruit</i> tree Leaves)	Twigs
Moisture	10.72	10.73	11.63
* Organic Matter	84.65	78.41	81.65
† Mineral Matter (ash)	4.60	10.83	5.72
	100.00	100.00	100.00
* Containing Nitrogen	1.18	.91	.72
Equal to Ammonia	1.43	1.10	.87
† Containing—			
Silica . . . . .	.04	3.53	.09
Oxide of Iron . . . . .	.23	—	.05
Alumina . . . . .	.03	—	.11
Lime	1.04	—	1.25
Magnesia . . . . .	.51	—	.33
Potash	1.09	.73	.68
Soda . . . . .	.07	—	.11
Phosphoric Acid . . . . .	.10	—	.13
Equal to tribasic Phos- phate of Lime . . . . .	.22	1.07	.28

(For detailed remarks *see* Chap. VII, paragraph 149.)J. (*see* Chap. VII, paragraph 127.)

Composition of Indian Oil-cake refuse used as Manure.

	Castor-oil Bean Cake or Castor refuse			<i>H-maya</i> (<i>Pongamia</i> <i>glabra</i>) refuse.
	1.	2.	3.	
	—	From Calcutta (milled).	From Mysore.	
Moisture	10.72	9.49	10.65	12.19
* Organic Matter	82.85	74.91	84.01	83.42
Total Phosphates	5.29	4.85	4.01	2.57
Alkaline Salts, etc. . . . .	.42	2.90	.75	1.85
Insoluble Siliceous Matter . . . . .	.69	7.75	.55	.74
	100.00	100.00	100.00	100.00
* Containing Nitrogen	4.94	4.35	4.89	7.54
Equal to Ammonia	5.93	5.23	5.94	4.79

Sample No. 2 was "milled," *i.e.*, crushed by machinery; the other samples were not, but were merely the refuse (after extraction of oil in the native way) roughly pressed together without the aid of machinery.

K. (see Chap. VII, paragraph 127.)

Composition of Indian Feeding-stuffs for Cattle.

	Earth-nut Cake		Gingelly or Tt seed Cake	Niger seed Cake	Hongay bean (<i>Pongamia glabra</i>)
	(Decor- ticated)	(Unde- corticated.)			
Moisture	8 10	9 80	8 03	11 90	9 68
Oil	7 26	6 50	13 01	6 43	9 23
* Albuminous Compounds .	47 81	47 31	38 92	34 01	24 93
Carbohydrates, Digestible Fibre, etc	25 02	19 8	22 12	22 27	47 42
Woody Fibre	4 86	10 25	4 70	17 14	4 70
† Mineral Matter (ash) .	6 95	6 85	13 22	8 25	4 14
	100 00	100 00	100 00	100 00	100 00
* Containing Nitrogen .	7 65	7 57	6 22	5 44	3 99
† Including sand . . .	3 25	—	2 89	1 25	—

	<i>Mahua</i> (<i>Bassia latifolia</i>) refusa from Distillery
Moisture	17 92
Oil	48
* Albuminous Compounds	3 44
Gum, Mucilage, etc	3 08
Sugar	64 40
Digestible Fibre	3 14
Woody Fibre	2 13
† Mineral Matter (ash)	5 43
	100 00
* Containing Nitrogen	55
† Including sand	2 90

The large amount of sugar in the *Mahua* refuse is noticeable.

L. (*see* Chap. VII, paragraph 136.)

Composition of Indian Bone-meals.

	1 (Pure)	2 (Pure)	3 (Adulterated)	4 (Adulterated)
Moisture	8 50	7 76	6 50	7 32
* Organic Matter	28 85	29 33	18 75	23 43
† Phosphoric Acid	25 00	24 08	18 15	22 08
Lime	33 79	32 55	37 55	33 88
Magnesia, Alkalies, etc	} 3 45 {	1 03	3 24	2 35
‡ Carbonic Acid		3 00	11 80	7 15
Insoluble Siliceous matter	40	2 24	4 01	3 78
	100 00	100 00	100 00	100 00
* Containing Nitrogen	4 12	4 04	2 78	3 35
Equal to Ammonia	5 00	4 90	3 38	4 07
† Equal to tribasic Phosphate of Lime	54 58	52 83	39 62	43 21
‡ Equal to Carbonate of Lime	—	6 82	26 82	16 25

M (*see* Chap. VII, paragraph 139.)Composition of Materials used to adulterate Indian Bone-meal.
(Samples taken at Mazagon Dock, Bombay, 10th January 1891.)

	A	B	C
Moisture	3 29	—	4 37
Lime	43 78	33 23	40 43
Magnesia	1 35	—	20 00
Oxide of Iron and Alumina	4 78	7 65	2 30
* Carbonic Acid	29 64	21 64	28 55
Alkalies, etc	4 70	5 83	4 05
* Insoluble Siliceous Matter	12 46	28 65	30
* Coloured	100 00	100 00	100 00
Equal to Carbonate of Lime	67 36	56 00	61 80

Samples
were not, re-

roughly prepared
A Grey-coloured
B Shell sand
C White Probably powdered magnesian limestone

Chap. XIV, paragraph 333.)

ns of Samples of Indian Wheat taken from
of Cultivators in the Cawnpore district.

paragraph 333 I have given a table setting out the per-
is kinds of impurities found in six samples of wheat
in threshing-floors of cultivators and cleaned in my

venient, however, in addition to stating the impurities
s, according as they happen to be large seeds and lumps
t, or small seeds and fine earth, etc., to give the impurities
lings that are recognized by the London Corn Trade

Village.	Barley, etc.*	Dirt †	Total other than Wheat
	per cent	per cent	per cent
Naipar	072	051	128
Cawnpore . . .	106	600	1000
Gotaya .	1120	590	1710
Lukhanpur	1010	1010	2020
Bawatpur	390	280	670
Nawabganj . .	660	540	1200
Average	720	512	1232

* The term "barley, etc." includes all grain of intrinsic value, such as
barley, peas, linseed, etc

† The term "dirt" includes earth, chaff, and miscellaneous weed seeds

No	—	Barley, etc	Dirt.	Total other than Wheat.
		per cent	per cent	per cent.
7	Bulk in Cawnpore Market . . .	271	82	353

(For further details see Chap XIV, paragraphs 333—4)

O. (see Chap. XIV, paragraph 388.)

MECHANICAL ANALYSES of Samples of Linseed taken from
Cultivators' Stores and threshing-floors

Mechanical Analyses of 18 Samples of Linseed from Bilaspur
district Central Provinces

No of sample	Whence taken	Impurities removed by sieving		Impurities removed by hand picking	
		Sieved Linseed	Impuri- ties	Pure Linseed.	Total Impurities
		per cent	per cent	per cent	per cent
1	From threshing floor	95.62	4.38	94.49	5.51
2	" store in house	90.21	9.79	87.70	12.30
3	" threshing floor	96.18	3.82	94.26	5.74
4	" " "	94.17	5.83	92.89	7.11
5	" store in house	97.07	2.93	95.81	4.19
6	" " "	93.83	6.17	92.07	7.93
7	" " "	90.08	9.92	87.88	12.12
8	" " "	95.35	4.65	93.61	6.39
9	" " "	95.33	4.67	93.10	6.90
10	" " "	91.32	8.68	89.83	10.17
11	" " "	94.31	5.69	92.93	7.07
12	" " "	94.24	5.76	92.81	7.19
13	" " "	94.72	5.28	93.12	6.88
14	" " "	96.03	3.97	94.18	5.82
15	" " "	92.13	7.86	89.83	10.67
16	" " "	96.29	3.71	95.52	4.48
17	" " "	96.28	3.72	95.36	4.64
18	" " "	97.86	2.14	96.66	3.34
Average				92.87	7.13

Mechanical Analyses of Four Samples of Linseed from Raipur
district, Central Provinces

No of sample	Whence taken	Impurities removed by sieving		Impurities removed by hand picking	
		Sieved Linseed	Impurities.	Pure Linseed	Total Impurities.
		per cent.	per cent	per cent.	per cent.
119	Consignment to a Trader	93.53	1.47	97.77	2.23
	Raipur market	91.83	8.12	92.85	7.15
	" " "	93.59	6.41	91.97	8.03
84	" " "	93.07	6.93	93.16	6.84
Average				93.94	6.06

Mechanical Analyses of Two Samples of Linseed from Jubbulpore district, Central Provinces.

No of Sample	Whence taken	Impurities removed by sieving		Impurities removed by hand-picking	
		Sieved Linseed	Impurities	Pure Linseed	Total Impurities
23	.	per cent 96 38	per cent 3 62	per cent 94 89	per cent 5 11
24	.	97 20	2 80	96 72	3 28
Average . . .				95 81	4 19

Mechanical Analyses of Two Samples of Linseed from Damoh district, Central Provinces

25	.	94 45	5 55	92 84	7 16
26	.	94 21	5 79	90 36	9 64
Average				91 60	8 40

Mechanical Analyses of 11 Samples of Linseed from Nagpur district, Central Provinces

27	Stored in house .	96 33	3 67	94 97	5 03
28	" "	97 22	2 78	96 24	3 76
29	From threshing floor	99 00	1 00	98 10	1 90
30	Stored in house	98 00	2 00	96 76	3 24
31	Brought to Hall; Brothers store .	98 19	1 81	97 34	2 66
32	From threshing floor	96 46	3 54	91 61	8 39
33	" "	97 20	2 80	96 05	3 95
34	" "	95 12	4 88	91 44	8 56
35	" "	96 70	3 30	94 51	5 49
36	" "	96 59	3 41	95 02	4 98
37	" "	99 15	85	96 60	1 40
Average				95 79	4 21

SUMMARY

Average of Samples from all the Five Districts	{	94 per cent. Pure Linseed	6 per cent. Total Impurities
------------------------------------------------	---	---------------------------	------------------------------

O. (see Chap. XIV, paragraph 388.)

MECHANICAL ANALYSES of Samples of Linseed taken from Cultivators' Stores and threshing-floors.

Mechanical Analyses of 18 Samples of Linseed from Bilaspur district, Central Provinces.

No of sample.	Whence taken.	Impurities removed by sieving.		Impurities removed by hand-picking.	
		Sieved Linseed.	Impurities.	Pure Linseed.	Total Impurities.
		per cent.	per cent.	per cent.	per cent.
1	From threshing floor .	95.62	4.38	94.49	5.51
2	" store in house .	90.21	9.79	87.70	12.30
3	" threshing-floor .	96.18	3.82	94.26	5.74
4	" " " .	94.17	5.83	92.89	7.11
5	" store in house .	97.07	2.93	95.81	4.19
6	" " " .	93.93	6.17	92.07	7.93
7	" " " .	90.08	9.92	87.88	12.12
8	" " " .	95.35	4.65	93.61	6.39
9	" " " .	95.33	4.67	93.10	6.90
10	" " " .	91.32	8.68	89.83	10.17
11	" " " .	94.31	5.69	92.93	7.07
12	" " " .	94.24	5.76	92.81	7.19
13	" " " .	94.72	5.28	93.12	6.88
14	" " " .	96.03	3.97	94.18	5.82
15	" " " .	92.12	7.88	89.33	10.67
16	" " " .	96.29	3.71	95.62	4.38
17	" " " .	96.28	3.72	95.36	4.64
18	" " " .	97.86	2.14	96.68	3.32
Average . .				92.87	7.13

Mechanical Analyses of Four Samples of Linseed from Raipur district, Central Provinces.

No. of sample.	Whence taken.	Impurities removed by sieving.		Impurities removed by hand-picking.	
		Sieved Linseed.	Impurities.	Pure Linseed.	Total Impurities.
		per cent.	per cent.	per cent.	per cent.
1	Assignment to a dealer.	98.63	1.47	97.77	2.23
2	* Equal market	94.83	5.12	92.85	7.15
3	" " .	93.59	6.41	91.97	8.03
4	" " .	95.07	4.93	93.16	6.84
Average . .				93.94	6.06

Mechanical Analyses of Two Samples of Linseed from Jubbulpore district, Central Provinces.

No of Sample.	Whencos taken	Impurities removed by sieving		Impurities removed by hand-picking	
		Sieved Linseed	Impurities	Pure Linseed	Total Impurities
		per cent.	per cent	per cent.	per cent
23	.	96 38	3 62	94 89	5 11
24	.	97 20	2 80	96 72	3 28
		Average . . .		95 81	4 19

Mechanical Analyses of Two Samples of Linseed from Damoh district, Central Provinces.

25	.	94 45	5 55	92 84	7 16
26	.	94 21	5 79	90 36	9 64
		Average .		91 60	8 40

Mechanical Analyses of 11 Samples of Linseed from Nagpur district, Central Provinces

27	Stored in house .	96 33	3 67	94 97	5 03
28	" "	97 22	2 78	96 24	3 76
29	From thrashing-floor .	99 00	1 00	98 10	1 90
30	Stored in house .	98 00	2 00	96 76	3 24
31	Brought to Balli Brothers store .	98 19	1 81	97 34	2 66
32	From thrashing-floor	96 46	3 64	94 61	5 39
33	" "	97 20	2 80	96 05	3 95
34	" "	95 12	4 88	91 44	8 56
35	" "	96 70	3 30	94 51	5 49
36	" "	96 59	3 41	95 02	4 98
37	" "	99 16	85	98 60	1 40
		Average .		95 79	4 21

SUMMARY.

Average of Samples from all the Five Districts .	{	94 per cent. Pure Linseed.	6 cent.
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MY TOURS, 1889-90.

TOURS.

(See Map of Tours)

Arrival in India, December 10th 1889.

First Tour . Dec 10th 1889 to May 19th 1890.

Second Tour . July 14th 1890 to Sept 12th 1890

Third Tour . Nov. 23rd 1890 to Jan. 10th 1891.

Departure from India, Jan 10th 1891.

Residence in India, 13 months

First Tour

NOTE—The references in the following account are to PARAGRAPHS in the foregoing Report

First Tour, Dec. 10th 1889 to May 19th 1890.

1889:

On November 21st 1889 and within a week from the time that my delegation to India was decided upon, I left London for Marseilles, and at the latter port joined the Peninsular and Oriental Company's steamship "Bokhara," the vessel which singularly enough had conveyed Sir James Caird to India when he went out in October 1878 as one of the Famine Commissioners. Hardly was I on board before I came in close and

London, Nov. 2
Marseilles, Nov. 23

agriculture in the person of Mr R H. I had previously known as a Scotchman his way to his coffee estates in Mysore felt in the progress of agriculture in

India, and in any movement for its improvement, rendered our meeting an invaluable assistance to me, and one which I had reason throughout my tour to be extremely glad of. Our daily conversations, and a study of the "Statistical Atlas of India" (a copy of which Sir Charles Bernard had kindly lent me), soon convinced me that I had before me a difficult and responsible task. On board the "Bokhara" I met Mr Justice Jardine, of the High Court Bombay, Mr Harvey James, Secretary to the Government of India in the Legislative Department, Dr Warburton (Kapurthala), Mr H F Brown (Kilburn & Co. Calcutta), Mr Apperley (indigo planter, Bettiah), one or two tea planters, a Punjab irrigation officer, Mr Oldham (late of the Public Works Department), and others more or less connected with Government Departments or with agriculture.

On coming within sight of Bombay I received a cordial invitation from Lord Reay, the Governor of Bombay, to go direct to Government House Malabar Point. Here, in addition to the Governor, I met Mr. Ozanne, Director of the Bombay Department of Agriculture, and Dr Theodore Cooke Principal of the College of Science, Poona. At an informal meeting next day with these gentlemen, Mr Elliot, and Mr Bhimabhai, Assistant Director of Agriculture, Bombay, we discussed the general points to which my attention would especially be directed during my tour.

Bombay, Dec. 20

On December 12th I travelled with Dr Cooke to Poona, and there met Mr Howman, who had come over from England in order to introduce the mechanical "cream-separator" and English systems of butter-making (para 284). December 13th was spent in going over the College of Science (para 520), and the Experimental Farm (para 493) attached to the College. Returning to Bombay, I left again on the evening of December 14th for Pachora, Mr Bhimabhai accompanying me. We were met at Pachora by Mr P. R. Mehta, a former student and diploma holder of Cirencester College, now the Superintendent of the Bhadgaon Experimental Farm.

Poona, Dec 12.

"much kindness and facilitated very greatly my rather difficult progress
" " " " " through Mr W S Sullivan,
" " " " " Cooper Cooley where I stayed
" " " " " Somawarpet and Sasavada
" " " " " my quarters in a desused
" " " " " succeeded in getting me

drivers to take me into Mysore territory, and pushed on to Sacra-
 Santa. Here I paid a visit to Mr Butcher, whose coffee plantations I
 went over, and then proceeded to Snklespoor, halting there for the night.
 The next morning's march (January 27) brought me to my destination,
 Bartchinhulla, Monjerabad where Mr Elliot met me, and here I remained
 until February 3rd. Under Mr Elliot's guidance I went over his different
 estates and neighbouring ones, seeing both the cultivation and the pre-
 paration of the coffee for sale (para 363). In this way, and in long
 conversations on matters concerning Indian agriculture in general, my
 time was fully and profitably engaged and the help Mr Elliot gave me
 then and since was simply invaluable to me. On February 3rd I had to leave,
 and proceeded by way of Chickmanlur and Kadur, the Southern Mahratta
 Railway, and Bangalore to Madras which I reached on February 5th. At
 Madras I was met by Mr O Benson, Assistant Director of the Department
 of Land Records and Agriculture with whom I stayed. His Excellency
 the Governor (Lord Curzon) gave me two interviews and I also had
 others with the Hon Mr (now Sir Henry) Stokes, and the Hon Mr
 Garstin, the two Members of Council, also with Mr H F Clogston,
 Director of the Department of Land Records and Agriculture, Mr C A
 Galton, Revenue Secretary, Mr J D Rees, Private Secretary to the
 Governor, Mr D Duocan Acting Director of Public Instruction, Mr
 C G. Douglas, Examiner of Forest Accounts and Mr W Kees, Acting
 Principal of the Sadsapet College. In company with Mr Rees I visited the
 Sadsapet College and Farm on February 6th (paras 523 and 493). Early on
 the morning of February 7th a conference was held at Mr Clogston's house, at
 which, in addition to Mr Clogston, Mr Benson, Colonel Olcott and myself,
 several of the leading native landowners were present, among them being
 Mr S Subramania Iyer, Mr R Ragunatha Row, and Mr M Iyaswami
 Pillai, also Mr P Rajaratas Mudhar and Mr C K Subba Row, Sub-
 assistant Director of Agriculture. In this way I was enabled to get some
 idea of the most pressing needs of agriculture in Southern India and to
 learn in what respects its circumstances differed from those in the more
 northern parts. I started off the same evening with Mr Benson on what
 was to me a very instructive and enjoyable tour through some of the
 districts in the southern part of Madras. Leaving Madras, we arrived on
 the morning of February 8th at Shiyali (Tanjore), after crossing the
 Coleroon river and coming upon the Tanjore delta, where rice was the
 principal crop then growing. At Shiyali we were met by Mr C Sabsooysgam
 Modhar who took us over his estate and showed us the rice cultivation
 upon it (para 317), and his well cared for ballocks and improved iron
 ploughs (para 281). In the evening we continued our journey by train,
 arriving next morning at Madras. Mr Rameshbabu Aiyar, and Mr.
 Tillansayagam Pillai, the Deputy Collector, the Mayor of the Municipality,
 and other gentlemen met us and drove us to the farm which formerly
 belonged to the Madras Farmers Club (para 489), but of which only the
 dairy-farming portion was maintained. Here our hosts had collected
 a number of the subordinate revenue officials and of the leading raiyats,
 and with the aid of an interpreter we had a long and, to me most
 interesting conversation, or rather conference. Similar gatherings of this
 kind were held at other stopping places during the tour, and in this way I
 was enabled to get much information. Mr Benson also had arranged for
 representative men to come up from some of the more distant parts, such
 as Tinnevely, which, for want of time I was unable to visit myself.

We left Madras in the evening, and passing by Trichinopoly, traversed the valley of the Cauvery until, gradually rising to the higher ground we reached Erode where soil and cultivation began to alter. Changing here on to the Madras Railway, we continued to rise until we came, in the afternoon of February 10th, to Mangalam (Aroosah Road) in the

Monjerapad
Jan. 27-Feb 8.

Madras Feb.
6-7

St. Louis, Feb 8

Madura, Feb 9.

Available
Feb 10-11.

Coimbatore district. We were taken to see the "garden" (irrigated by wells) cultivation, and the system of enclosing fields with hedges (para 240). Going on to Avenashi itself, we were shown betel-vine plantations, the folding of sheep and goats on the land (para 126) the utilisation of mud from tank beds (para 132), the growing of perennial cotton (para 388), the manufacture of saltpetre (nitre) (para. 183) and the breed of Coimbatore sheep. Late in the evening of February 11th we left Avenashi, and while Mr Benson went direct to Salem I struck off alone to Mettappollium, and thence drove up the hill to Ootacamund, reaching this lovely hill station on the morning of the 12th inst. I was unfortunate in not finding Mr Lawson the Government Botanist, in residence, but I met Mr D Hooper, the Government Quinologist, and also Major General Morgan, who told me a good deal about tea growing in the Neighberries (paras 357 and 358). The next morning Mr Hooper took me over the Government cinchona plantations and stores, and also over the Dodabatta Tea Estate. I left Ootacamund on the evening of the 13th, and joined Mr Benson at Salem on the 14th. Preparations were then being made for an Agricultural Show that was shortly to be held here. Mr Benson and I drove out some 10 miles into the country and saw the cultivation both on unirrigated ("dry") land and on that irrigated from "tanks," and that watered by wells ("garden" land). Millets, tobacco, sugarcane and many kinds of vegetables were prominent crops, and here I saw the old fashioned wooden sugar-mills at work (para 287). On our way back I went to see Mr Hooper, Deputy Conservator of Forests, and had a conversation with him upon the administration of forests in Madras. The same evening I left Salem and returned to Madras on February 15th, where I paid a second visit to the Saidapet College and had an interview with Mr Riess, the acting Principal, after which His Excellency the Governor gave me a second audience. The next day I visited the Hon Mr Stokes and subsequently Mr Van Gaezel, the Chemical Examiner of Madras, leaving in the evening for Bombay, en route for Sangor in the Central Provinces, where I was to meet Mr J B Fuller Commissioner of Settlements and Agriculture Central Provinces. The first portion of the journey took me through the Bellary and Raichur districts, and I arrived at Bombay on the morning of February 18th. I employed the day in interviewing commercial men in Bombay and in getting from them information as to the conditions of the trade in wheat (para. 378 *et seq.*), oil seeds (para 389), cotton (para. 338), feeding cakes (para 127) bones (para 142), and other manures, as well as agricultural machinery. Among others I met Mr John Marshall, Secretary of the Bombay Chamber of Commerce Messrs Fielay, Muir & Co, Messrs. Volkart Brothers and Mr Shallis. In the evening I left again, going on, via Bhunsawal and Itarsi, to Sangor which was reached on the morning of February 20th. Mr Fuller arrived in camp on the 21st, and meantime I had a look at the cultivation around, a great deal of it consisting of market gardening. We did not move on until the morning of the 23rd, but then shifted our camp daily until in successive stages we reached Damoh on February 28th. Mr T C Wilson, Settlement Officer, joined us on the march. The principal crops which I saw were wheat, linseed, gram, and other pulses. During the journey I was made acquainted with the systems of Land Classification and of Land Settlement (para 46) adopted in these Provinces and I examined in many places the work and maps of the village accountants and district inspectors. We reached Damoh on the 24th, after passing Sanoda, and on the 25th we crossed the stone formation, and arrived at Damoh on the evening of February 27th. I took leave of Mr Fuller the next morning and pushed on to Jabul pore. Here I called upon Mr Lindsay Neill Divisional Commissioner, and Colonel Van Someren, Conservator of Forests. In the evening I left for Allahabad, arriving at the latter place on the morning of March 2nd. I made the acquaintance here of (the late) Mr S A. Hill, of the Muir College, one of the few scientific chemists sent out from England to India. I had a long conversation with Mr Hill relative to the position of

Ootacamund,
Feb 12-13

Salem, Feb 14

Madras Feb
16-18Bombay Feb
18

Sangor Feb 20.

Damoh, Feb 27.

Jabalpore

March 1.

Allahabad,

March 1.

scientific men (para 436) and the prospects of Native students becoming workers in chemical science (para 423) The same evening I travelled towards Cawnpore and there next morning and went out to the Cawnpore Experimental Farm (para 478) The corn crops were at this time nearly ripe Mr J F Duthie Director of Botany for Northern India joined me in the evening and next morning we went together to the Cawnpore Farm, where I made the acquaintance of Mr T W Holderness Director of the Department of Land Records and Agriculture North West Provinces and Oudh We drove out to the Jubb Reservoir and the Amramau Farm, to see the experiments carried out on the reclamation of sterile salty land (*usar*) (para 75) In the evening Mr Duthie and I left for Aligarh where on 5th March, we carefully inspected the Chherat Farm (para 75) and on 6th March the Gurakran Farm (para 75) at both of which places experiments on salty lands (*usar*) reclamation were being conducted on a large scale and were kept under botanical observation by Mr. Duthie On 7th March we left Aligarh Mr Duthie going to Saharanpur and I to Meerut I called on Mr Whiteway, the Collector and in the afternoon was driven out to see the splendid market garden cultivation carried on around the city by the Jât Lodha and Sâni castes (para 149) I also was shown over the farm belonging, to Rai Bahadur Debi Singh, which was formerly an Experimental farm of the Agricultural Department of the North West Provinces and Oudh and on which improved iron ploughs are still employed (para 476) The next morning I drove on to the Bahoghur Farm (para 269) at Hapur where there is an Army Remount Depot, and where horse breeding operations are carried on Captain Goad Assistant Superintendent of the Remount Department, took me over the Depot and farm, and showed me the horses and the methods of cultivation employed such as the growing of oats and lucerne ploughing with iron ploughs drawn by horses instead of bullocks and the working of wells by horses Leaving Hapur on the morning of 9th March, I returned to Meerut, and then went on to Delhi, where I spent a day seeing the sights, and left again on the morning of the 11th for Saharanpur Arrived there, I met Mr Duthie and also Mr Patterson the Collector On 12th March Mr Duthie and I went over the Saharanpur Botanical Gardens and saw the various plants and trees which were very interesting to me as being the first I had seen in India At the invitation of Colonel Dean Superintendent of the Army Remount Department, I saw the Saharanpur Depot on the morning of the 13th, the horses here being principally Australian horses ('Walers') imported for the use of medium cavalry and field artillery Colonel Dean also drove me over the adjoining farm, lucerne and oats as at Hapur being largely grown After this I posted from Saharanpur to Dehra Dun reaching the latter in the evening and going to Mr E Fernandez then Deputy Director of the Forest School The next morning I called on Colonel Bailey the Director, and shortly afterwards Mr H C Hill Officiating Inspector General of Forests, arrived. This seasonal examinations of the Forest School were in progress at this time and as these were the last of the season I took the opportunity afforded me of attending them and of ascertaining in some measure what the standard of teaching attained in the Forest School was (para 526) Mr C Bagshaw Conservator of Forests, Central Circle North-West Provinces (the late) Mr W E D Arcey, Assistant Inspector General of Forests Mr L Merer Deputy Conservator (Dehra Dun district) and Mr A Smythes Instructor of the Forest School were present, in addition to Colonel Bailey, Mr Hill, Mr Fernandez and myself I attended the examination and was asked to question a number of the students on the morphology (para 526) of the plants and on the laboratory and museum collections I then returned back to Saharanpur and on the morning of the 15th I drove to Dehra Dun and Agricultural Show was held (para 511) This interested me greatly, especially the ploughing competition (para 249) and I met again Mr Holderness Mr Whiteway and Mr. Muhammad Hossain I returned to Saharanpur the night of the 20th, and spent the next three days there, going over the Botanical Gardens, the Museum

Cawnpore
March 3-4

Aligarh
March 5-6

Meerut
March 7

Hapur March 8

Delhi March
9-10
Saharanpur
March 11-13

Dehra Dun
March 13-16

Meerut,
March 18-20

Saharanpur,
March 21-23.

and Herbarium, and being taken by Mr. Gol'an to see the cultivation of the neighbourhood, which was largely market-gardening of a high class the cultivators being principally Sânis. At Saharanpur I met Mr. Benson, the District

suggestion, I travelled to Hurdwar

hand
On
o the
Mr Lucknow,
March 7th

very marked (para 88). On 2nd April the crops of the experimental plots

Gahmer,
April 8-9.

Shahabad district, and were received there by Messrs Thomson and Mylne
a considerable portion of the Peheea
sugar cane but also the manufac-
tury (paras 267, 288, 330), the shallow
the "centrifugal drier" or sugar
re Thomson and Mylne Indigo was
was also shown the records and maps

Dehrees, April 8.

kept by Messrs Thomson and Mylne for the purpose of managing their Estate, which extends to about 25000 acres. In the evening we journeyed on to Garaul on the Tirhoot State Railway, and visited the Batoulia Estate and factory, which are under the charge of Mr P G Wilkinson. On the 7th April we took the train on to Mozufferpore, where I was entertained by Mr A C Brett, the District Judge. At Mozufferpore I met a large number of indigo planters who had come in from the surrounding districts, as also Mr Schrottky, who had been resident some time in India, and was then regarded by some as a "chemical expert" in the manufacture of indigo (para 349). On the 8th

Garaul, April 6.

Mozufferpore,
April 7.

we, then managed by Mr.
nile of days, returning to
11th instant we went to

Motipore,
April 8-9

see the Dhanpur factory and estate of Mr G Macdonald, comprising, in all, 7000 acres. In the evening I set off alone to make my way to Leps in the Darbhanga district, which I reached next day after riding 30 miles on a trolley kindly provided for me by Mr Walton, the engineer of the line.

Patna,
April 12-13.

At Patna
the
On
Anga,
where

Begowlie,
April 14-16.

at Mr J. J. Macleod's estate (Lall Serahi) I

met Mr Wishart. We
ghbourhood. Two out-
at (Mr D O Reid) and
16th we all travelled to
a parade of the Behar
indigo planters of the
collector, and Mr. Seeley,
the 17th April to Pepra,

Motihari,
April 17.

Pepra April 18

Seeraha April 19

Bebeen, April 20

Mr W B Hudson's at Seeraha, and went over his estate and factory the day
following, leaving in the evening for Bara (Mr Gale's) And thence by train
to Bebeen, where I parted company with Mr. Gale. On the 21st I took the
and paid another short
of the 21st I took the
met Mr. A. J. Hughee

Allahabad
April 22-23

with the consent of the Government
the North-West Provinces where
public and sewerage schemes, and
I had originally intended to make a chemical and agricultural point of view.
from Tirhoot, but I found the season too far advanced to permit of this, the
cold season (*rabi*) crops being already off the land. Consequently I adopted
the alternative plan and visited in succession Allahabad, Cawnpore,
Benares, and lastly Noida Tal. At Allahabad, on April 22nd, in company
with Mr Hughes, I saw the new waterworks then in course of construction.
In the afternoon I was shown over the Allahabad Grass Farm by Colonel
Marniott of the Commissariat Department (para. 215 *et seq*), and he explained
to me the system on which the Farm is worked. Grass was then being cut
and put into silos (para. 224). On the morning of the 23rd I examined
with Mr Edmonson, the sanitary officer, the system of
tranching of eight-inch soil upon land at Fattah
distance out of the town, and another at
utilised for a sewage farm. At Allahabad
Mr F. W. Porter, the Collector, and Dr Hall superintendent of the Gaol
I went with Mr Hughes on the morning of the 24th to see the pumping
station and new intake from the Jumna. After this I left Allahabad and
travelled to Cawnpore.

Batt April
24-26

well as by draining and pumping, had
ing a large amount of land that was
ough was then at work on a portion
of ravine land was also reclaimed
flow of water (para. 70). Two days
party and seeing the villages included
in it and also their cultivation. I travelled to Cawnpore on the evening of
the 26th April, and put up at Mr Wishart's. The next morning I went with
Mr Wishart to the different impurities
and determined in Mr.
Wishart's
the canal side and saw the
plot of land on which Kachhi cultivators use
the town refuse, and after that to other land outside Cawnpore where eight-
soil was being tranching (para. 149).

Cawnpore April
27-May 2

On the 28th I went over some cotton mills, and on the 29th inspected
with Mr. Hughee, the proposed intake of water from the Ganges, after which
I met Mr Walter Butler (engineer), Mr F N Wright (the Collector), Major
Baddeloy, of the Army Harness Factory, Dr Condon (civil surgeon), and
Mr J Rogers (engineer). The next day Mr G B Allen took me over
Messrs Conper, Allen & Co's Army Boot Factory, and then I went on to
the Cawnpore Experimental Farm. The next day, after inspecting the site
for a proposed sewage farm Major Baddeloy took me to see the Army Harness

Factory, and in the evening, Colonel Worsley and I walked over the Cantonment Grass Farm (para. 214) On May 2nd I met Mr. W J

General, May
3-6

intended to be utilized for the purpose of a sewage farm.

At Buenos I made the acquaintance of Mr. Adams, the Commissioner, Mr. James White, the Collector, and Mr W Venie, analyst to the Municipality. From Buenos I returned, on May 6th, to Lucknow, where I met Dr Führer, keeper of the Lucknow Museum, and Mr E Smith, of the Archaeological Department. I went over " " " " " "

well boring 1,200 feet deep . . .

for the city In the after-

Railway for Naini Tal, meeting en route Colonel Aitcher, formerly Assistant
 Director of Agriculture, North-West Provinces and Oudh, and Mr W J.
 Wilson, with whom I continued the journey. Naini Tal was reached the Naini Tal, May
 afternoon of May 7th, and here I stayed until May 16th. At Naini Tal I 7-10
 met a number of the officials of the North-West Government, and had many
 interesting interviews. Among these I would mention one with His Honour
 the Lieutenant-Governor (Sir Auckland Colvin), and several with Mr T
 W. Helderess (Director of the Agricultural Department), Colonel Pitcher,
 Mr T H. Wickes (chief engineer, North-West Provinces and Oudh), and
 Mr A. J. Hughes. In addition, I had the pleasure of meeting the Hon W
 Woodburn (Chief Secretary to Government) and Colonel Erskine, also
 Mr. R. Smeaton (Financial Secretary to Government), Mr C. J. Connell
 (Secretary, Board of Revenue), Colonel Thomson, Colonel Harrison
 (Chief Engineer, Irrigation, North-West Provinces and Oudh), Dr

disposal of the sewage of this and station. On May 17th a hot hour 1st, ending, on my way down the hill, at Mr S L Whympere's an old school-fellow of mine. Taking the train at Kathgedam I travelled on to Bareilly, and thence, via Saharanpur, to Umballa, which was reached by the evening of May 18th. Posting from here through the night, I came next morning to Kalka, and finally arrived at Simla early in the afternoon of May 19. I stayed in Simla from that date until July 18th. I employed this interval in putting together the notes I had taken during my tour, in reading Settlement and other Reports of the districts I had visited, as well as the principal Government papers upon subjects with which my inquiry was more specially concerned. I had also the opportunity of meeting a number of the high officials of Government, all of whom received me most kindly and gave me much assistance. His Excellency the Viceroy especially showed much interest in the matter of my inquiry, and gave me renewed interviews. The Members of Council, Sir David Barbour, Sir George Chesney, Sir Charles Elliott, the Hon. Mr Hutchins, and Sir James Lyall also allowed me to discuss with them the views I had formed. Among other officials whom I met, and by whose experience I benefited greatly, were the following:—
 Agricultural Department:—
 Mr. J. F. Finlay, Mr. J. E. O'Connor, Mr. F. A. Robertson (Director of Agricultural Department, Punjab), Mr. S. A. Hill, and Major Elliott (Commissionariat Department). The library and records of the Agricultural Department were placed at my disposal, and Mr. Tucker, the Registrar,

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James Mr J. F. Finlay, Mr J. E. O'Connor, Mr F. A. Robertson (Director of Agricultural Department, Punjab), Mr S. A. Hill, and Major Elliott (Commissionariat Department). The library and records of the Agricultural Department were placed at my disposal, and Mr Tucker, the Registrar.

helped me in every way he could. Before leaving for my second tour, I drew up my general conclusions in the form of "Preliminary Notes," which were printed and circulated and subsequently discussed at the Agricultural Conference in the following October.

Second Tour
1890.

Second Tour, July 14th to Sept. 12th 1890.

- Just after the rains had set in I started off again on my travels, and leaving Simla on July 14th in company with Dr. Hendley, or Joypore, assing by way of Delhi, we arrived on
- Here I had an agricultural talk with the Joypore State, Rai Bahadur Kamtee second, under Dr. Hendley's guidance,
- en to Ahmedabad, arriving James, the Commissioner, an Ozano (Director of Agriculture, Baroda Coll my tour through the Rai seeing the cultivation of tanks, also the growing of perennial cotton, the sowing of rainy-season crops, and the preparation of land for rice and the transplanting of rice. From Ahmedabad we passed on early on the 22nd, to Nadiad, where we were joined by Mr. Kacherao Jadhava, a Native in the service of the Gaekwar of Baroda, and formerly a student at Cirencester College. We were met at Nadiad by Rai Bahadur Becherdas Viharidas Desai, a leading agriculturist, by Mr. Motibhai the President of the Municipality, and by the Secretary of the Nadiad Agricultural Association. After visiting a store in the town established for the purpose of selling pure seed (para 310) we went to the Experimental Farm of the association (para. 484), and to Mr. Becherdas's own farm. After this we went out again to see the cultivation of the neighbourhood, the fields enclosed with hedges (para 240) and with borders of grass around them (para 211) being prominent features. We also visited here a hospital (Pinjrapol) for disabled and dying cattle. The same evening we left for Baroda, and stayed there with Mr. F. A. H. Elliott (Survey Commissioner). On the next morning we went over the fields out of which it was proposed to form an Experimental Station and Farm in connection with the Baroda College (para 435). After breakfast
- Baroda July 23
- Baroda Survey. In the evening we left, and travelled to Indhar, in the Mahim district, whence we drove to Mahim. Here we saw the splendid "garden" cultivation, the growing of sugar cane, plantains, ginger, betel-nut, and other remunerative crops (para 110), besides the system of seed-bed formation, known as *radh* (para 187), for rice and millet (*naoli*) growing. At Mahim we met Mr. Dhondo Vinayak Pandekar, a leading landed proprietor, Mr. Padmakar Narayan, *Mamlatdar* of Mahim, and many others. In the afternoon we drove back to Polghar, and thence by train to Bombay. The next day I called on Mr. John Marshall, of the Chamber of Commerce, and had a long talk with him on the subject of wheat-clearing (para. 376 *et seq.*), and oil seed cleaning (para 378) and upon the trade in cotton (para. 313). From Messrs. Croft, Wells & Co. I gathered information on the collection and export of bones (para 142), from Messrs. Vekart Brothers on trade in cotton, bones, and manures, and from Messrs. Glado & Co. on the manufacture and trade in oil-cakes (para 127). On the 26th inst. we went on to Poona, I leaving the others at Kukee, as I was to be His Excellency the Governor's (Lord Harris) guest at Ganesh Khind. Mr. Lee-Warner, Political Secretary to Government,
- Simla, July 14.
- Joypore, July 17-18.
- Ahmedabad, July 20-21.
- Nadiad July 22.
- Baroda July 23.
- Mahim, July 24.
- Bombay, July 25.
- Poona July 26-27.

was also staying at Osnesh Khind at the time. With Mr Oranne I went over the Ganesb Khind Gardens (para 496), and on July 28th drove with him and Mr Middleton to Mundwa a few miles out of Poona, to see the sugar-cane and other cultivation of the district which is carried on by canal irrigation and the use of night-soil (*inodrette*) (para 149). We also went over a distillery where spirit is made from the fruit of the *Malaba* tree. In the afternoon I met at the office of the Department of Land Records and Agriculture Mr Bhambhai, the Assistant Director, and later on we held a conference with the principal landowners, agriculturists, and native officials of Poona. Among those present besides Mr Oranne, Mr Middleton, Mr Bhambhai, and myself, were Rai Bahadur Mahdeo Govind Ranade (Judge under the Deccan Relief Act), Rai Bahadur Yeshwant Moreishwar Kelkar (Oriental Interpreter to the Government), Mr Dorabji Padamji (President of Poona Municipality), Mr. Naosoji, manager of West Paper Mills, Mr. Namjoshi and Mr. Ghotandelar, editors of native papers, Mr. Knapaswami Mudhar (Secretary of the Agricultural Society of Western India), Mr. Dandekar (Educational Inspector of the Berar), Mr. Neta and Dr. Ghole, landowners. We had a long and interesting conversation and interchange of views, more especially on points connected with forest adminis-

Bulgaum, July
29-30

Deputy Collector, the Hon. Gahrshitapa Virbisara, we heard of the success which had attended the efforts to popularise the system of Government Advances (*faccars*) for agricultural purposes (para 100). Next day we inspected the farm attached to the Agricultural Class of the High School (para 522), and then went to see the market gardening around the town. At noon we left for Bellary, passing en route Dhárwar, Gadag, and Hubli. At Bellary, where we arrived on the morning of 31st July, Mr A. Sabapathi Mudhar met us and took us to his farm, where he showed us the utilization of prickly pear as green fodder (para 236) the Swedish clover which he uses on his estate (paras 277, 281) and the preparation of bones for manure, (para 143). Owing to the late coming of the monsoon and absence of irrigation there were hardly any crops on the ground, so we did not stay long here, but retraced our steps to Hospet, which we came to in the afternoon. Mr C. H. Goud met us here, and under his guidance we saw the rice and sugar-cane cultivation of the district. The enclosure of the fields with trees for supplying green manure for the use of grass for cattle along the water-lane. Irrigation is by means of *trawls*, and the cultivation is excellent.

Bellary, July 31

Hospet July 31.

the cultivators are mostly of the Lingayat caste. Iron sugar mills are used

Hampi Aug. 1.

Rijapur, Aug.
2-3

Poona, Aug. 4.

Kolhan, Aug. 8.

Bhadgaon, Aug
6-7.

and reached Pachora on the morning of 6th August, going on thence to the Bhadgaon Farm, which we reached after crossing four different rivers; these were then in flood, and presented considerable difficulty to our passage. Arrived at the Farm, we went carefully over it (para 482), seeing then the rainy-season (*kharif*) crops, just as on my previous visit I had seen the cold-weather (*rabi*) crops. We also saw the herd of Mysore cattle (para. 255), the formation of a *babul* (*Acacia arabica*) plantation (para. 186), and the making of silage (para 226). The next day we left, and, after visiting a cotton-cleaning (*ginning*) factory en route, at Pachora I parted company with Mr. Ozanne and Mr. Middleton. Taking the train on to Nagpur, I arrived there on the morning of the 8th, and went to Mr. J. B. Fuller's, where I stayed this and the next two days. At Nagpur I had an interview with Mr. J. B. Fuller, Mr. J. B. Fuller, Mr. J. B. Fuller, and among

Nagpur, Aug.
6-10.

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Calcutta, Aug
13.

Emigration,
Berasgunge,
the villages
with their
cultivation (para. 214). At Berasgunge, Mr. Edmund Macdonell,
manager of the Berasgunge, Mr. J. B. Fuller, and

Berasgunge,
Aug. 14-17.

Calcutta, Aug.
18-19

The day following I had an interview with Mr. R. Blechynden, Secretary
of the Agricul. in relation to the
coming of a connected with the
cultivation an evening Mr. Nolan.

Dumraon, Aug.
20-21.

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Bahador Jai Prakash Lal, the manager of the Bahadur Estate (para 177) in the afternoon Mr F. A. Gauges at Moka.

Where we arrived on the morning *Seebara*, to see the cutting and steeping of the *Aug 27-28*, aration of the dye in its different we went on to *Methari*, and stayed *Methari, Aug 23*.

Here I met again Mr. Apperley and Mr. Seeley. On the morning following, we went with Mr. Elyth by train to *Bettiah*, and were the guests of Mr. T. M. Gibbon, manager of the *Bettiah Estates*. The country here was much flooded, but we saw the cultivation as far as we could, and I had much interesting conversation with Mr. Gibbon. The following morning we left again, and at *Methari* I ended my tour with Mr. Fumaneau, and proceeded alone to *Allahabad*, which I reached on August 26th. Here I visited Mr. S. A. Hall and Captain F. C. Chapman, and went over the *Allahabad Grass Farm* again with Captain Hallowes and Sergeant Meagher (para 215). A large quantity of silage was being made at the time (para 224). I took the night train to *Cawnpore*, and, arriving there on the 27th, I drove to the *Experimental Farm* and made another inspection of it with Mr. Lachman Parshad, the personal assistant to the Director. After calling on Mr. Wishart I left again for *Hissar*, where on the 28th inst. I was to meet Mr. F. A. Robertson, Director of Land Records and Agriculture, Punjab, and to make, under his guidance, a short tour in the Punjab. I duly arrived at *Hissar* and met Mr. Robertson, we both staying with Captain Marrett, Superintendent of the *Hissar Cattle Farm*. On the morning of the 29th Captain Marrett drove me over the *Grass Farm* for some 10 miles to *Kharwan*, where we saw the different herds of cattle kept on the farm (see para. 254). On our return we found Colonel Patch (Commissary General, Northern Circle, Bengal) and Captain (now Major) Wingate (Special Forage Officer), and had a conversation upon the system of *Grass Farms* (para 215). We then went over the *Home Farm*, and saw the *young stock*, as also the growing of *Lucerne* and other green crops (para 230), and the making of *silage* (paras 224, 226). Next day we met Mr. A. Anderson (Deputy Commissioner) and went with him to see the cultivation of the neighbourhood, both on canal irrigated and on unirrigated ("dry") land. Later on we visited the *sheep and goat-breeding Farm* (para. 270), and left in the evening for *Ferozepore*, arriving there early on August 31st. Mr. E. B. Francis (Deputy Commissioner) took charge of us, and drove us round to see the cultivation near the town, as well as the system of *inundation canals* (para. 92). On September 1st we drove out towards *Ludhiana*, and saw several villages where the cultivation was merely carried on by men of the *Jat* caste. In the afternoon we left for *Changa Manga*, and put up at the Forest bungalow. Mr. A. V. Munro, Assistant Conservator, and Mr. Fazl Bux, Sub-assistant Conservator, took us over the "reserves" (paras 177, 221) and *grass runs* (*runkars*), as also to the more distant *runka Jelleke*.

In the evening we took the train to *Multan*, and got there early on September 3rd, going to the Deputy Commissioner's, Mr. H. C. Cookson. Mr. Cookson drove me round the town, showing me the cultivation and the *inundation canals* (para 92), and later on to the more outlying parts, where, among other things, I saw the manufacture of *indigo* according to the native method. On September 4th Mr. Cookson, Mr. Smith (Executive Engineer, *Sidhuani Canal*), and I, went by train to *Rasbida*, and there rode out to see the system of *canal distribution* and some of the villages which had been established along the *Sidhuani Canal* since the latter had been brought to the district (para 86). Previous to this only a small part of the area had been under cultivation. On the morning of September 5th Mr. Cookson and Mr. Smith returned to *Multan*, and I continued my journey with Mr. Robertson to *Lahore*, *Montgomery* being passed on the way. On the 6th inst. Mr. A. V. Munro met us again, and took us over the *Shabdera plantation* (para 177), a little outside *Lahore*. After this

Multan, Sept. 3.

Rasbida, Sept. 4.

Lahore, Sept. 6.

we went to the veterinary school, dispensary, and hospital, and saw the stations of the Horse-breeding Department which are kept here (para 263). Starting off again in the evening by train, Mr Robertson and I reached Gujrât (Punjab), Gujrât (Punjab) and were met by Mr E B Steedman, Deputy Commissioner, and formerly Director of Agriculture, Punjab, and by Chaitan Davies, Settlement Collector. The following morning we rode out and saw the crops, here mostly irrigated from wells. We passed also large tracts of land flooded with silt from the mountain streams and channels, and which form the rich wheat growing stretches of these parts (para. 138). Splendid cattle, which came originally from Hissar, were seen here (para 254), and there was also a Dépôt of the Horse-breeding Department (para 269). We left Gujrât at night, and arrived next morning at Mian Mir, where we halted to see one of the military Grass Farms. The one we visited was *malā Terah*, and the grass was then being cut and a great deal was being packed into silos dug in the ground (para 229). From here we went on to Amritsar, and became the guests of Mr J. A. Grant, Deputy Commissioner. Mr Grant took us in the afternoon to see the town, its temples, etc., and also the system of town sanitation so successfully adopted here (para 149). On September 9th we were out early, and spent a long morning in seeing the extensive market-garden cultivation carried on all round Amritsar by the help of irrigation from the canal (Bar-Doab Canal), and the night soil and sweepings from the town (para 149). Vegetables were being raised in great profusion, also sugar cane and maize. We passed on to a village, *Saltanwind*, on the other side of the canal where canal irrigation is only partial, and wells are dug for supplementing it. Returning to Amritsar, we made a closer inspection of the sanitation system (para 149), and went to other land on which the sullage water is pumped. Later in the day I met Mr E Nichol the secretary to the Municipal Committee, and he explained to me in detail what had been done. In the evening we left for Hirtspoor, where Dr Warburton met us and drove us out to Kapurthala. Here we were met by Major Massey, the Superintendent of the Kapurthala State. We received a visit next morning from the Rajah of Kapurthala, which we returned in the afternoon. Meem Aziz Bukhsh, the Collector of the State, also came and had an agricultural conversation with me. I here to acknowledge much valuable information and many useful suggestions given to me by Major Massey during our stay. Later on we drove out to see the cultivation and the plantations that had been started round the town. On the morning of September 11th we left Kapurthala, and drove, via Jullundur, to Hoshiarpur, a distance of 36 miles. The road took us past excellent cultivation and we made several halts on the way to see this or that object of special interest. Cultivation by well irrigation was a marked feature, and we saw a great deal of digging of wells going on, the wells in places, being quite near the surface. Sugar cane was extensively grown. We passed some wide sandy tracts known as the "chob" lands (para 71), where no cultivation exists, but the soil is covered with transported, or "blown" sand. Arrived at Hoshiarpur, Mr Robertson had the village records and maps of the village accountants (*patwaris*) brought for my inspection; later on we drove out to see the cultivation round the town. Sugar cane was the principal crop growing, and large quantities of manure are used for it, the night soil and town refuse being assiduously saved (para 149). Cactus hedges encircle the fields, and firewood is fairly abundant. An Arab stallion belonging to the Horse breeding Department is kept here (para. 269). After calling on Colonel Wood, the Deputy Commissioner, we left Hoshiarpur and drove back the 25 miles to Jullundur, from which we took the train to Umballa, where we arrived on the morning of September 12th. We halted in short time to see the cotton crops which grow here on unirrigated land (wells being hard to dig) and then drove to Karnal, finally concluding my second tour by reaching Simla on the evening of September 12th.

I now had to settle down to prepare for (1) the Agricultural Conference, which was to meet at Simla on October 6th and following days, (2) the compilation of my report. My work was, however, delayed for a time by

Gujrât (Punjab),
Sept 7

Mian Mir,
Sept 8

Amritsar
Sept 8-9.

Kapurthala
Sept 10

Hoshiarpur
Sept 11

Umballa,
Sept 12

Simla Sept 12

an attack of malarial fever, contracted, doubtless, during my Punjab tour with Mr Robertson, for Mr Robertson was laid up at the same time, and unfortunately was ill for some time afterwards. My attack lasted but a short time, and on getting well enough, Dr Watt took me with him for a very enjoyable three days' trip to the Sonai Valley, and the basin of the Sutlej river. On my return I found myself once again among the officials whom I had met in the previous May and June, and who had given me so much help. In addition I met Mr R. S. Whitall, Mr. McIntyre, and Mr. J. H. Laco, all of the Forest Department.

Mr J. B. Fuller (Commissioner of Settlements and Agriculture, Central Provinces), arrived in Simla on September 29th, previous to the sittings of the Agricultural Conference, and on October 4th Sir Edward Buck returned from furlough, and resumed the duties of his office. Mr Clogstoun, Mr. Nolan, Mr. Ozanne, Mr Finucane, Dr Theodore Cooke, and Mr Middleton,

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science,
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which I had visited, and made copious extracts from Government Papers and Records which I found in the library of the Revenue and Agricultural Department. On November 1st I began the actual writing of my first Report, and from now until the 23rd instant, when I left Simla, I wrote and had printed off the first twelve chapters, in such a form that I was able, before leaving India, to send them to different people for perusal. In the correction of these proofs Sir Edward Buck, Mr J. B. Fuller, Mr. J. E. O'Connor, Mr Ozanne, Mr. Finucane, and Mr H. C. Hill, gave me most valuable help.

Third Tour, November 3rd 1890 to January 10th 1891.

Third Tour.

I left Simla on November 23rd, and after reaching Umballa, took the train for Ajmere, where I had arranged to meet Mr H. C. Hill, and to see the Ajmera-Ajmerwara forests (para 181). I got to Ajmere very early on the morning of November 25th, and later on set off with Mr Hill to the Nagpur forests, where we saw the "reserves" that had been made on the hill sides around Ajmere. We then came down the hill again, and went first to Pokhar, where nurseries are formed, and then to Pushkar where a Fair was being held, and at which there were a great number of horses, many of them very good. In the afternoon Mr Hill and I went to the *Mohwa* (para 181), another "reserve" on the other side of Ajmere. We made an early start next morning, took the train to Biawar, and rode until we came to the "Chang reserve," which is principally used for supplying firewood, small timber, and grass, as well as for pasture in time of drought. This we went carefully through (para 181). Sirdar Hara Singh, the Sub-assistant Conservator, was present in person to meet us, and we ended up at Sondra. From this place I proceeded next morning alone, but met Sir Edward Buck in the train, and we went on in company to Bombay, taking the train in the afternoon to Poona. In the train with us were Dr. Steel and Dr. Grainger, of the Veterinary Department. Mr Ozanne and Dr Theodore Cooke met us at Poona, and the same evening I made the acquaintance of Dr. Langard, who had lately arrived at Poona as Imperial

Simla, Nov 23

Ajmere, Nov 25.

Ajmere reserves, Nov 25.

Bombay, Nov 29.

Poona, Nov 29-30

Dec 3

hatched Bacteriological
or of Bombay (Lord
Rhind, and stayed
number of the Bombay
breeding Operations,
and Mr. Morrison, the newly-appointed Superintendent of Government Farms,
Bombay. We stayed at Poona until December 3rd, when Sir Edward Buck

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture,—No. 3—37-21, dated Calcutta, the 20th March 1897.

READ—

Part I, Famine Commissioners' Report.

Despatch No. 19, dated 14th March 1881, to Secretary of State.

Despatch No. 55, dated 16th June 1881, from Secretary of State.

Government of India, Resolution No. 6—340-50-G., dated 8th December 1881.

Despatch No. 151, dated 26th May 1882, to Secretary of State.

Despatch No. 197, dated 21st July 1888, to Secretary of State.

Despatch No. 104, dated 13th December 1888, from Secretary of State.

Despatch No. 6, dated 1st June 1889, to Secretary of State.

Despatch No. 103, dated 7th November 1889, from Secretary of State.

Government of India, Resolution No. 545—55 C.I., dated 25th March 1890.

Government of India, Resolution No. 24—21-17, dated 22nd June 1893.

Government of India, Resolution No. 2—13-1, dated 31st January 1894.

Government of India, Resolution No. 15—93-1, dated 7th September 1895.

Government of India, Resolution No. 17—05-1, dated 17th September 1895.

Government of India, Resolution No. 19—93-1, dated 20th September 1895.

Government of India, Resolution No. 20—353-1, dated 2nd October 1895.

READ ALSO—

Dr. Voelcker's Report on Indian Agriculture, 1893.

Calcutta Survey Conference Proceedings of 1882.

Calcutta Statistical Conference Proceedings of 1883

Delhi Agricultural " " " 1888.

Simla " " " " 1890.

" " " " " 1893.

Letters from the Chief Commissioner, Burma, Nos. 123—S—3, dated 6th December 1895, 784—11-A—1, dated 27th March 1896, and 86—8-A—3, dated 3rd July 1896.

Letter from the Secretary for Berry to the Resident, Hyderabad, No 124, dated 13th May 1896.

Letters from the Chief Commissioner, Assam, Nos. 62-A.—2016-R and 276 A —2019 R, dated 30th May 1896, and No. 185-A —2099-R, dated 4th June 1896.

Letters from the Government of Bombay, Nos. 4587, dated 10th June 1896, and 1337, dated 15th July 1896.

Letter from the Government of the North-Western Provinces and Oudh, No 2012, dated 10th June 1896.

Letter from the Government of the Punjab, No. 193-S, dated 17th June 1896.

Letter from the Government of Bengal, No. 630 T-R., dated 24th June 1896

Letter from the Chief Commissioner, Central Provinces, No. 2416, dated 7th July 1896.

Letters from the Government of Madras, Nos 438 and 491, dated 24th September 1896.

*Resolutions on the Proceedings of the Agricultural Conferences of
1893 and of 1895-96.*

FIRST RESOLUTION.

PREFACE

In October 1893 a conference was held at Simla attended by delegates from all provinces for the purpose of discussing the scheme of agricultural enquiry and improvement, for the promotion of which departments of land records and agriculture had been constituted under orders issued by the Secretary of State in 1881. The report of the Conference of 1893 was circulated to all local Governments and administrations for preliminary consideration with Resolution No. 2, dated 31st January 1894.

In a subsequent Resolution No. 15, dated 7th September 1895, each provincial government was invited to arrange for a local conference which should discuss the question how far the proposals and recommendations embodied in the report of 1893 could be adapted to the circumstances of the province addressed. The proceedings of all conferences, together with the views of all local governments and administrations thereon, are now before the Government of India who, as intimated in 1894, will deal with the subjects concerned in a series of separate Resolutions.

The present or *first* Resolution will be confined to an historical summary of the circumstances which have led up to the present position, and to a brief statement of the subjects which will be dealt with in the Resolutions to which it is a preface.

2. The policy of creating special departments to investigate the conditions of agriculture in India with a view to agricultural improvement was first brought forward in 1868 by the Commission appointed to deal with the Orissa famine, and the subject was brought under very full consideration by Lord Mayo's Government in 1870. The result of the deliberations then held was an important scheme for the constitution of both imperial and provincial departments of agriculture. It was represented to Her Majesty's Secretary of State that while a central department was necessary for co-ordinating the programme of enquiry and the results of investigation, yet that the 'real work of studying and improving agriculture must rest with provincial departments'. It was proposed, therefore, that a department should be created in every province under the control of an official director. In accordance, however, with the Secretary of State's instructions the step first taken was the formation in 1871 of a new branch of the imperial secretariat which was to deal with the development of the general scheme. This measure was followed in 1875 by the establishment of a provincial department of agriculture in the North Western Provinces by Sir John Strachey who had as a member of Lord

Mayo's Government taken a leading part in the original programme. Further development was checked by the financial difficulties which were due to the famine and scarcity prevailing in 1876, 1877 and 1878, and which not only prevented new action in the provinces, but led to the temporary suppression of the imperial department in 1879. It is interesting, however, to note that the very famine which thus arrested progress brought about the resuscitation of Lord Mayo's scheme on a wider and firmer basis by attracting renewed attention to the importance of improving Indian agriculture. The original scheme had been initiated by the Commission which dealt with the Orissa Famine. The revised scheme was put forward ten years later by the 'Famine Commission' which investigated the causes and phenomena of famine in all parts of India. The fact that the creation of agricultural departments has thus been twice due to the deliberate and unprejudiced conclusions formed by special Commissions appointed to advise the Government on the action which should be taken to cope with famine and its attendant evils, is a strong argument in favour of the scheme for agricultural improvement.

3 The Famine Commission was sent out in 1878 to this country at the instance of Parliament with a mission to enquire "how far it is possible for Government, by its action, to diminish the severity of famines or to place the people in a better condition for enduring them." The Commissioners, after a prolonged tour through India, submitted their report in 1880. They gave prominent consideration to the desirability of extending railways and communications, of enlarging the canal system, and of otherwise expanding the large protective works of the country. They also suggested the measures which should be taken on the actual occurrence of scarcity or famine. But the greater part of their report was occupied with recommendations for the reform of land administration. They were the first to point out that, on the one hand, prevent or minimize agricultural loss and distress, or, on the other hand, tend to increase and improve the produce of agricultural land. They advised that for dealing with these matters imperial and provincial departments of agriculture should be established.

4 In pursuance of the Famine Commissioners' advice an imperial department was created in 1881, which at once, under the instructions of Her Majesty's Secretary of State, took measures to arrange with the local Governments for the organization of provincial departments. In an opening Resolution of 1881, the duties of the new departments were summed up by the Government of India, following the Secretary of State, as agricultural enquiry, agricultural improvement, and famine relief. The third of these duties, which is concerned with the conduct of operations

to the actual event of scarcity, has been dealt with in the famine codes drawn up in 1882 and revised in recent years, and forms no part of the discussions now under review. Present considerations are confined to the measures which should be taken to secure an effective scheme of agricultural enquiry, *i.e.*, the collection of agricultural information, facts and statistics, and to open the way to improvements in agricultural methods and practices.

5 No pains were spared by the imperial and provincial Governments to subject the recommendations of the Famine Commissioners to the most intelligent criticism that could be brought to bear upon them. Every scheme or measure of importance that was from time to time proposed or suggested was placed before a conference at which every province concerned was represented by selected officials and experts connected with the administration of land or with the conduct of the agricultural departments. Thus, in 1882, a *first* conference was convened at Calcutta at which the principles were determined on which future cadastral surveys which are the basis of agricultural statistics should be conducted. A *second* general conference, held at Calcutta in 1883, prepared a scheme for the registration of inland trade statistics and for the compilation and publication of agricultural and trade returns. A *third* at Delhi in 1888 dealt with the important subject of agricultural education.

6 In 1889, correspondence with Her Majesty's Secretary of State led to an important event in the history of the agricultural programme, *viz.*, the deputation to India of a second Commission from home in the person of Dr Voelcker consulting chemist to the Royal Agricultural Society, whose mission was 'to advise on the best course to be adopted in order to apply the teachings of agricultural chemistry, and in order to effect improvements in Indian agriculture'. Every branch of agricultural enquiry and reform was thus to be open to his examination. Dr Voelcker, following 'the example of the Famine Commissioners, made a tour through India and gained a general knowledge of the directions in which agricultural enquiry and improvement might be developed. His report may be viewed as an amplification in detail of the recommendations of the Famine Commissioners, with which in all important matters his views were in general accord.

In every province he had the opportunity of consulting the local authorities, and before writing his report had the advantage of meeting, at Simla, a *fourth* general conference of delegates and experts from all provinces who went over with him the whole ground of the Famine Commissioners' recommendations so far as they applied to agricultural enquiry and improvement. His report when received two years later was submitted in Simla in 1893, to the consideration of a *fifth* general conference, whose recommendations have now been separately discussed by a committee of selected officers at the head-quarters of each province.

7 The Governor General in Council is not disposed to regret the time which has been occupied by continuous deliberation. The scheme of 1880 was so vast in its design, so important in its

objects, so wide in its scope, as to demand that the utmost care and caution should be bestowed on its full development. Material progress has indeed been made. The earlier years of the past decade were occupied in laying the foundations of agricultural enquiry by the organization of land record establishments, in inaugurating investigation in many important directions, and in developing plans of agricultural experiment. Such successive conferences led to further advance and to new measures. But the general principles and policy by which the whole scheme of agricultural enquiry and improvement were to be governed had not been finally or precisely formulated. The very complete examination of the issues left for decision which has now been made by provincial authorities and local Governments, places the Government of India for the first time in a position to amplify, with further approach to precision, the instructions of the Resolution of 1881, in which the duties of imperial and agricultural departments were necessarily sketched only in broad and rough outline. It must be understood, however, that progress has only advanced to one more stage. Further steps that is taken in future years will rest to further knowledge of facts and conditions, and will open up new issues. The time may soon come when the combined advice and counsel of provincial authorities, and of the experts by whom they are aided, will again be required for placing provincial and imperial governments in a position to decide what further measures

by the facts and statistics of the land records. These latter, it is true, supply continuous information regarding crops, irrigation, the occupancy and cultivation of land, and other circumstances connected with agriculture, without which no sound conclusions can be formed as to the general condition and needs of each agricultural tract. But, as pointed out by the Famine Commissioners, and later on, the enquiry was extended to all matters relating to the character of the soils and the diseases of plants—their causes and the means by which they can be prevented, minimized or cured, the extension of irrigation, the effect and value of canal water, the improvement of fuel and fodder supplies, the reclamation of waste lands, meteorological phenomena, economic products, improvement of old, and introduction of new, staples and agricultural implements, possible reforms in the methods and practices of cultivation, all such subjects as these were to form part of the programme of enquiry.

10 It was evident that in exploring the fields of investigation thus briefly sketched, the agricultural departments, imperial and provincial, must, as the Famine Commissioners had indicated, be assisted by competent experts. Some of the ground indeed had already been occupied by scientific investigators, thus for many years geological surveys had been carried out, and the strata of each province had been arranged in the flora and fauna. The Government had laid the foundation of a knowledge of the weather and climates of India, while in some provinces, and notably in Madras, measures had been taken to investigate and improve agricultural conditions. But it was obvious that much more was necessary for the carrying out of a systematic enquiry, and that equally competent experts were required.

and provincial authorities. In other words, that there must be an imperial as well as a provincial scheme of scientific enquiry. In many directions the work of investigation was national rather than local in character. It demanded the services of first class experts, such as each province could not afford and did not indeed separately require. The existing departments of geology and meteorology were cases in point. Scientific research in such fields could not be restricted to geographical or administrative limits, and would, if confined within narrower limits than those of the empire, involve waste of power and unnecessary expenditure. Influenced by these views, the Government of India accepted the

under systematic enquiry by experts attached to the imperial department.

The general character of the national scheme of scientific

enquiry under imperial direction, the extent to which it has been widened, the directions in which further amplification is necessary or desirable, and the association with it of provincial co-operation, form the subject of the *fourth* Resolution of this series.

11 To provincial departments, under the control and direction of local Governments, is left the largest share in the programme of scientific enquiry. It embraces all such investigations by experts as may properly and usefully be confined within geographical and administrative limits and includes, therefore, almost all enquiries and efforts directly aimed at the increase of agricultural produce. Such are, for instance, investigations having for their object the improvement of old, and the introduction of new, staples, the effect and value of canal water, reform in agricultural methods and practices, and the like. Enquiries of this kind are dependent on local conditions of soil, climate, custom, etc., and have often indeed to be carried out at various centres within each province. Government farms, estates under the management of Courts of Wards, estates belonging to Government, farms of landholders willing to co-operate with the provincial departments, these are the experimental fields in which the local experts are mainly required to work.

The general character of the scheme of scientific enquiry under provincial direction will be dealt with in the *fifth* Resolution.

12. The recommendations of Dr Voelcker, of the two conferences of 1890 and 1893 as well as of those recently held, have confirmed the view that investigation must precede improvement. But, as investigation proceeds in the numerous fields in which it has been or will be inaugurated, palpable and conclusive improvements are, as experience has shown, continually brought to light, remedies for existing evils are discovered and useful modifications of agricultural practices are ascertained. Every effort should now be made to take such measures as will permit the country to derive the fullest advantage from these results. The most important matter is the proper education of the agriculturist. For the Government of India still hold to the opinion expressed in the opening Resolution of 1881, and again in the Resolutions convening the conferences of 1890, 1891, and 1895-96, that no important reforms can be safely or widely introduced into the agricultural system without the general co-operation of the farming classes, whose intelligent and willing aid cannot be expected 'until their education has been so directed as to enable them to appreciate and, where expedient, to adopt the results obtained by the systematic and continuous enquiries of experts.' This view has been strongly confirmed by the various conferences which have recently discussed the question, and has been supported by all local Governments and administrations concerned.

The subject of educational reform, so far as it concerns agricultural interests, will be dealt with in the *sixth* Resolution of the series.

13. In the despatch of 1891, in which the views of the Secretary of State on the duties of the new departments of Agriculture

were communicated, attention was drawn to the obligation which the Famine Commissioners had desired to be placed on them, 'to render available agricultural and economic facts and statistics for every part of India in order that Government and its officers may always be in possession of an adequate knowledge of the actual

resources.' A wide in-

ction. It must be held to

every branch of enquiry

imperial and provincial

departments, must be intelligently collated and published on such plan as will bring the information gathered in an accessible form to the early knowledge of those whom it may concern. Much has been done in this direction.

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15 The Resolutions which have thus been announced are the

outcome of the experience and developments of the fifteen years

which have passed since the Famine Commissioners' report was,

under the orders of Her Majesty's Secretary of State, first made

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to them should be strictly imposed

importance which the Government of India attaches to

possession by all officials of

SECOND RESOLUTION.

LAND RECORD ESTABLISHMENTS.

The foundation of all land administration is the field. More specially must agricultural inquiry and reform, which are now recognized as an integral part of land administration, be based upon the facts and figures of the individual field of

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The first requisite in any programme for agricultural inquiry and improvement is, therefore, the efficiency of the land-record establishments.

2. To each village or group of villages in this country there had always been attached a village accountant. His hereditary duties are to provide annually for each field a correct record of area, occupancy, rent, crops and of other facts and statistics called for by his official superiors. In some parts of India a hereditary claim to the office has been scrupulously maintained. In others the hereditary right has been greatly weakened or entirely abandoned. But whatever may be the position of the hereditary claim, the hereditary duties of the office have still to be performed, and since the conduct of land administration and agricultural reform depend largely on the records of the village officer it becomes a primary duty of the authorities to take such measures as may be necessary to secure his efficiency.

3. As soon as the subject came under the special consideration of the Government of India, it was found that in many provinces the hereditary claim to the office had been allowed to override more or less the claim of the State to the efficiency of the holder of it; that the village officer was often incompetent, and not seldom so incompetent as to require an assistant for the performance of his work; that the land records had become incomplete and untrustworthy; that in some districts attempts to maintain anything like a correct record had ceased; that in others the office itself had been allowed to die out.

It had been proved, on the other hand, by results already obtained in more than one province that the village registers could be made to yield that punctual information of the circumstances of every agricultural tract which the Famine Commissioners had urged to be necessary for timely provision against scarcity, that the accountants could be trained to correct their maps from year to year in accordance with facts upon the ground, that their records, when carefully maintained, tended to facilitate the work of civil and land revenue courts, to cheapen litigation, and to provide every person concerned with an easy means of ascertaining or establishing his rights and interests in land. It had been foreseen too, that many direct economies should be effected by improving the village staff, that in some of the temporarily assessed provinces a correct record would mean a material reduction in the cost of periodic settlements, that, by a proper use of the village agency, expenditure on field surveys alone might be reduced from something like Rs. 200 to Rs. 50 a square mile, and that a series of annual statistics extending over a long period would afford a safer and broader basis for land assessment than the facts and figures hastily collected in a single year at great cost by huge temporary establishments.

4 When, therefore in pursuance of the Famine Commissioners' recommendations new departments were, under the orders of Her Majesty's Secretary of State, created in each province for the purpose of dealing with agricultural facts and statistics, as a foundation for agricultural improvement, the Government of India desired that they should be made specially responsible to the local Governments and administrations for the restoration and improvement of the land record, and for the competence and efficiency of the officials by whom it was to be maintained. This, indeed, was to be their first duty. The Famine Commission held the belief, to which expression had been given by Lord Mayo's Government ten years earlier, that agricultural science applied to Indian soils could materially increase the produce of the land and would thus go far to minimize the sufferings of the people in a season of scarcity, and it was in this view that they demanded the employment of agricultural experts and the creation of agricultural departments. But it was foreseen by the Government of India that attempts at agricultural development would require many years of continuous and patient investigation by experts before they could be expected to yield important or safe results, that in many cases they must be based on facts and figures which could only be derived from a long series of correct maps and records, and that everywhere the introduction of improvements into the agricultural system would require the instructed intelligence and co-operation of a class whose education had hardly yet begun. In the opening Resolution, therefore, of 1881, which presented the duties of the new departments, it was laid down that attempts at agricultural improvement must be for a time subordinated to agricultural enquiry. This meant that the provision and the maintenance of correct maps and records, upon which enquiry was to be based, must be the first stage in schemes of agricultural reform.

6 Another important consideration justified this course. It was anticipated that after the excitement caused by the 1878 famine had subsided, the time might come, when, under circumstances of financial pressure, costly departments whose efforts had been subjected to hostile criticism. It was every effort to turn the first to remunerative work. It had improvement of the land record and was maintained could at least

The policy was justified by subsequent events. The Finance Committee of 1886, which included among its members the writer of the Famine Report of 1880, and was, therefore, fully cognizant of the important advantages of agricultural investigation and experiment, came to the definite conclusion that expenditure on agricultural departments could not, under existing circumstances, be justified unless it could be shown that they were or would be directly remunerative. The departments were subjected accordingly to this financial test. In almost every case it was found that, independently of the indirect advantages derived from an improved land record, a direct financial saving was or would be effected aggregating a total of from 200 or 300 lakhs of rupees, that the economy was mainly due to the training, utilization, and proper supervision of the village officer; that where excess expenditure had occurred, it was in some degree due to the partial exclusion of the village officer from the scheme, and to the substitution for him of more expensive agency. The question then arose whether in those provinces where outlay exceeded income the departments could be retained.

6. The Government of India, in dealing with the results of the financial enquiry, accepted the fact that the indirect advantages of a land record were so great as to afford, even in the one or two cases in which outlay was found to exceed income, a strong plea for the maintenance of the provincial departments. They recognized that the extent to which the services of the village officer were financially useful must vary with the conditions of each province, that in the permanently settled districts of Madras and Bengal, for instance, his charts and records would not be required for purposes of assessment to the same extent as elsewhere, that while, on the one hand, in the eastern provinces a new map was called for every year by the fluctuations of the cultivated area, due to accidents of floods or to the practice of shifting tillage, on the other hand in the great ryotwari tracts of the southern and western presidencies what was justly termed 'a magnificent piece of machinery' dependent for its solidity on pillars marking the boundary of every field, had been constructed, which would, if

maintained go far to minimize the employment of the village officer on annual or periodical revisions of survey.

Influenced by such considerations as these, as well as by the fact that in almost every province the utilization of village establishments had been found remunerative, the Governor General in Council did not impose any further condition on the maintenance of departments of land records and agriculture than to require, with the concurrence of Her Majesty's Secretary of State, that the maximum use shall be made of the village officer under all circumstances in which his employment can lead to further economy. In this view the claim of the State to his efficiency must be held to be paramount over all other claims.

7 In dealing with the question the following circumstances must be borne in mind. The class to whom, by custom or by right of descent the office belongs is intelligent and quick to learn, the status of the hereditary appointment, however poorly paid, is, where the right is strictly maintained, so far an object of ambition to the members of the family to which it is attached, as to justify a condition that they should, after a sufficient term of grace, qualify themselves for it, that cheap educational institutions provided at public expense are available to all who are likely to be candidates for the office, that, according to the evidence adduced at the recent conferences, supplementary schools can, at no great cost, be established for training them in those special branches of their duties which lie outside the ordinary educational curriculum. It may, therefore, safely be laid down that after a given date no village officer should be admitted to an appointment, who cannot satisfy the educational test required.

The test imposed must, in the opinion of the Government of India, include a sufficient knowledge of survey and mensuration to enable a village officer to maintain correctly a map of the circle under his charge. Even in districts where surveys will require least revision, the village officer must be competent to enter new fields and sub-divisions of fields upon his map. But whether or not he is likely to be called upon to execute an actual field survey, he should in any case be made to acquire that intelligent comprehension of a map, and of the relation between a map and the ground upon it, which can only be gained by practice in map work on the field.

The Government of India would have some hesitation in forcing this obligation if it entailed any real difficulty. The evidence adduced at the recent conferences and the results obtained even in provinces and native states where the village officers had for many years been neglected, show that any school lad of the class from which village officers are recruited can, as a rule, be taught in a few weeks a sufficient knowledge of the field survey, under proper supervision, to enable him to maintain a map correctly.

8 The proceedings at the conferences have shown that the utilization of village officers has reached its highest point. It is difficult to explain why this should be the case. In the utilization of village establishments had been reached its highest point.

creation of the new departments of land records, the hereditary claim, though not disregarded, was made strictly subservient to efficiency, close supervision was exercised over the village officials; the salary of the office was gradually raised, and considerable encouragement was given to those who held it by ensuring the promotion of the best men to supervisorships and other higher appointments. The rules lay down that at least two thirds of the supervisors should be taken from the ranks of the village officers.

The Government of India are not prepared to advocate that the Punjab rules should be taken as a precise model for other provinces, but they commend the principles underlying them as sound. They think that the time should come when in every province a fair educational test including competence to survey, should be strictly imposed, adequate pay for the office should be provided, and excellence of work should be the condition to higher appointments. On one hand, care should be taken to raise the educational standard of the agricultural population has not reached a high level, that the status of the village officer is not so unduly raised as to give him too masterful a position in the village or group of villages under his charge and that, on the other, the admission of village officers into the ranks of their supervisors should not be made so free as to endanger the high standard of excellence which the controlling staff is, for reasons hereinafter given, expected to attain.

9 The history of the supervisor is very similar to that of the village officer. As in each village there was, under native rule, an accountant, so to each of the administrative circles, containing perhaps one or two hundred villages into which a district was divided, there was attached an official whose main duty it was to collate the returns received from village accountants, and to obtain such information of the agricultural and financial condition of the circle as might be required for purposes of assessment and of land revenue administration. On investigation the original functions of the office were found to have been often forgotten, sometimes the office had disappeared, almost everywhere the hereditary claim to it had overridden all other considerations, not infrequently the incumbent was so illiterate or incapable as to be unable to perform without assistance any official duties at all, and, as a general rule, the duties assigned to him were quite outside the traditional functions of his office.

10 When the reform of the land record system was taken in hand, the first step in almost every province was to restore the hereditary duties and functions of the circle officer. In some parts of India, where the hereditary responsibilities had been forgotten, the hereditary right to the office had been nevertheless even more strongly maintained than that of the village officer, and much care had to be taken to prevent it from being unduly interfered with by the initiation of too trenchant reforms. In such cases older men were allowed to appoint substitutes or educated relatives, time was given to the younger to learn how to perform efficiently the real duties of their office, only those of the latter who were hopelessly

incapable were ejected. At the same time it was found that a material expansion of the staff had become necessary. The extension of cultivated area, the growth of population, the demand for more elaborate statistics, all these and similar causes had doubled the work which had to be done. The number of circle officers that had sufficed for the needs of the earlier years of the century was wholly inadequate now. In almost every province, therefore, the staff was largely increased by the incorporation in it of the best of the men who had been for some years engaged in supervising the subordinate establishments of survey and settlement parties in the field. These recruits brought into the ranks of the effete service the very experience which was wanting. They were active men, accustomed to direct and control, and experts in the construction of field maps and field records. Their example proved of great value to the hereditary staff.

The duties, partly peripatetic and partly sedentary, of the office, had, so far as they had been performed, been hitherto unaltered. They were now divided. The circles were increased in number, and the areas correspondingly contracted. To each circle was attached a "peripatetic" officer for inspecting and controlling the work of 40 or 50 village officers. At the head quarters of each of the administrative sub-divisions of a district, perhaps from 5 to 10 in number, and each comprising 2 or 3 peripatetic circles, was located the "sedentary" official. The younger and more active of the staff were placed in charge of the smaller peripatetic circles. The older men were assigned to the sedentary office. The main duties of the peripatetic circle officers were to instruct the village officers, to examine their work, to note and report defects, to relieve as far as possible the higher officials from the necessity of personally inspecting the village officer's maps and records, to provide for his circle quick and early information of any kind that might be urgently called for in connection with the land or the people upon it, as well as periodical reports on the agricultural condition of the area under his charge, and finally, to fulfil the various executive duties which a season of scarcity of famine might entail. The main duties of the "sedentary" officials were to examine the various returns sent in from the villages and to compile them in abstract forms for his group of circles. At the head-quarters of the district a head supervisor was established, who was to make a similar compilation for the whole district and to superintend generally the work of the whole staff. The functions of the higher officials and covenanted officers were, as pointed out in an imperial Resolution of 1853, no longer to include the detailed inspection of the village officers' maps and records, but were to be confined to such an examination of the supervisor's work as would prove whether or not their duties of inspection and control were being properly performed, and to the adoption of such measures, punitive or otherwise, as might tend to improve their efficiency.

Such was the general character of the scheme of inspection and supervision which, with due regard to the varying conditions of each province, has been established in every part of India. In those permanently settled districts of Madras and the

which the village officer has either disappeared or has not been brought under official control. The proceedings of the recent conferences have now afforded to the Government of India the opportunity of ascertaining in what directions the improvement of the supervising machinery may in some provinces still be possible.

11. One important matter is the confinement of the supervising officers to their proper functions. They should not, on the one hand, be allowed to perform the duties of the village staff, nor, on the other, those which proper staff. In some cases an over-estimate of the capacity of the village officers, or a distrust of their capacity to learn, has led to the transfer of a portion of the village duties to the supervising staff. The extravagant tendency of this procedure was pointed out by the Finance Commission. In other cases the important duty of inspection has been interfered with by the practice of using the supervisors for enquiries and reports on matters unconnected with the village records. This may, as in the Punjab, be checked by forbidding any order for reports and enquiries, other than for those prescribed by the rules, to be issued by sub-divisional or district officers. On either hand a transgression of the limits within which the duties of the office should be confined must be carefully prevented.

12. The next point to which attention may be drawn is the proper instruction of the supervising staff in survey. In the imperial Resolution of 1882* in which the general principles on which the cadastral surveys of the country should be con-

* No. 45 S., dated 4th September 1882

out. But unless confidence in the accuracy of village field maps can be assured by professional supervision, and unless the maps connected with the survey stations the trigonometrical and topographical always be a danger that the details supplied by the provincial establishments will not be accepted by the professional officers responsible for topographical cartography, and that the details already mapped by the land-record staff may have to be mapped over again at great and unnecessary cost by the professional staff. Hitherto the survey operations which have been conducted in almost every province have not only supplied a large percentage of recruits, professionally trained in survey, for the circle staff, but have afforded a field for the instruction of the previously existing circle officers. This will not be the case in future. Henceforward a practical knowledge of, and experience in, approved professional methods will, if precautions be not taken, gradually die out; and, as has already occurred in some cases, the field maps will become more and more inaccurate and unequal in quality. It is of importance that this result should not be allowed to occur, especially as, independently of the requirements of cartography, the maintenance of field maps up to a reasonably

fair standard is for all purposes of administration desirable. It is considered in some provinces that the best security against a gradual decline in the value of field maps, whenever these have been initially laid down on professional lines, is the periodical transfer of a limited number of survey officers of responsible position from the professional staff, whose duty it should be to preserve a knowledge of correct methods throughout all grades in the land-record staff and to personally supervise or inspect all surveys which are of a materially more important character than the mere revision of a village map. This policy has been accepted in Madras, in Bombay, and to some extent in the Central and North-West Provinces, while very full effect has been given to it in Burma, where the exceptionally shifting character of the cultivation has justified the employment in every district of a superior officer who is either transferred from the Survey Department or is thoroughly trained in survey. The Governor General in Council now desires that the question may receive full and careful consideration in every province, in which no measures have yet been taken, for providing for the maintenance of maps on a correct professional basis and how far the central guidance of competent experts is likely to be useful.

13. A third matter is the improvement of the supervising staff by securing for the best men in it a reasonable prospect of promotion to higher service. The advantages of this course were pointed out in an imperial Resolution of 1883.

No 232, dated 14th March 1883
It was then urged that promotion should not merely be permissible but obligatory, that it was not unnatural that vacancies in the regular line should usually be offered to those officials, or to their friends, who come most into personal contact with the officers in whose hands patronage rests, and that since the duties of circle officers usually confine them to outlying parts of the district, their claim to promotion in the regular line is apt to be overlooked unless a certain number of such appointments are strictly reserved for duly qualified members of the supervising staff.

14. Very inadequate effect seems to have been given to this policy except in the Panjab, where its success has been marked. No less than one-third of the circle officers have been in the last few years admitted to the higher revenue appointments, and now no difficulty is found in attracting young men of good family and high educational attainments as candidates for the supervisorships. By degrees the educational test has been raised, and the time will doubtless come when the appointments will be readily sought for by men who have obtained a graduate's degree at a University or a diploma at an Agricultural College.

A further advantage of the policy was indicated in the 1883 Resolution. It was contended that, as the supervising officials acquire from the nature of their duties a considerable knowledge of agriculture and of the conditions and circumstances of the agricultural classes, a free flow of promotion from their ranks would

infuse into the upper grades of the revenue service a useful acquaintance with the agricultural conditions of the district or province in which they hold office. The Government of India is pleased to observe from the proceedings now before them that this view has received strong support from both the conferences and the local Governments, and that the advantage of leavening the revenue service with officials who have learned their work in the field is fully recognized. In the Punjab the value of the experience gained by a circle officer is so thoroughly appreciated that every candidate for a revenue appointment, whether a circle officer or not, is made to serve an apprenticeship, which may extend to two years, as a supervisor, and the plan is commended to the notice of all local Governments and administrations.

15. A difficulty is, in some provinces presented by the circumstance that the educational standard prescribed for entry into the upper grades of the revenue service is far higher than that which is, or can for some time be, imposed for a circle supervisorship. In those provinces in which education has advanced rapidly, and which universities are of the longest standing, at the same time the inspecting staff has not kept pace with the advance.

While the revenue appointments of ambition to university graduates have been filled by men from whom no educational test of any value has been required. The one service has slowly advanced, the other slowly declined in quality, a gulf has been created between the two which it is not easy to bridge.

In other provinces again, of which the Punjab may be taken as an example, the measures taken to improve the supervisor class were antecedent to the introduction of that high education which is represented by a university. A long period of survey and settlement operations, conducted, as a rule, without the assistance of the professional survey department, had created a large supervising staff in which existing circle officers were temporarily included, and from which it was easy to select for transfer to the permanent circle staff, intelligent and capable recruits with the very experience that was wanted for the management and control of village officers. On the other hand, the educational standard for higher revenue posts was, as is still the case, low in comparison with that in provinces with universities of long standing. The new men, with their practical experience, were found to be often better and more intelligent officers than many of those occupying higher positions. There is, therefore, in no wide gulf to be bridged, and the quality of the service has been improved.

16. The Government of India, while recognising the fact that the attainment of a policy of perfection must be a work of slow growth, conceive it to be necessary that a 'working plan' should be laid down for the gradual development of a sound system, and that the wide breach, where it exists, between the perpetuating service and the administrative service must be gradually narrowed.

and eventually closed. In provinces which have in recent years undergone survey operations, no wiser course can probably be followed than either to select for the peripatetic appointments the best of the survey supervisors who have gained a practical knowledge of field duties, or to train existing circle officers up to the same standard. But a date should be named after which mere field experience and an acquaintance with the village land records should not, without much higher qualifications than these, admit a candidate to a circle appointment.

17. Taking a broad view of the subject, the Government of India have, upon a review of the conference proceedings and the letters with which they are forwarded, arrived at the following conclusions. They deem that a serious obligation rests upon the State to utilize to the utmost extent for the benefit of the public service the educational system established in the country, that the time must come, as indeed in some parts of India it has come, when all officials required for the conduct of business connected with the land, excepting only those whose duties are of entirely a subordinate character, must attain the educational standard represented by a graduate's degree or some equivalent diploma, that it is of equal importance that every official who has to do with land administration should have learned by practical experience the conditions prevailing upon the land with which he will have to deal, that he should be familiar with its agricultural system, with the character and customs of the people upon it, with the methods and principles on which the record of changing facts and circumstances is maintained; that in this view the experience of the large peripatetic staff employed throughout the empire, to the number of several thousands, on duties which ensure the requisite experience, should not be thrown away, that no opportunity should be lost of drawing from its ranks selected men of proved excellence for service in the higher appointments, and that in order to give effect to this policy, the educational standard of the peripatetic staff must be gradually so raised as to guarantee the intellectual fitness of the men who are to be drafted from it. With the advance of education, increasing competition for pensioned employment, and a widening opportunity of promotion to the upper grades of official service, there will, in the opinion of the Government of India, be no need to fear that the field service will fail to attract candidates of high educational attainments.

Such a result would be desirable in the interests alone of the maintenance of a correct land record and of the proper training and control of the village subordinates by whom it is maintained, but it has an even higher importance in securing the efficiency of the higher official service upon which the conduct of the land administration of the empire mainly devolves.

THIRD RESOLUTION.

UTILIZATION OF LAND RECORDS.

1. In 1874 Her Majesty's Secretary of State pressed upon the Government of India the facts and statistics obtainable in the object of collecting agricultural statistics. In the following year on this subject, explained that the object aimed at by Lord Mayo's Government in proposing the establishment of agricultural departments had been the establishment of a specific branch of the administration whose prime duty it should be to suggest measures for the development of agricultural industry, that one part of this duty was to consist in the collection of statistics which would be the basis of the records maintained by village accountants.

Four years later the Famine Commissioners, adverting to these injunctions, confirmed the Secretary of State's view, and recorded their opinion that 'the revenue system in the greater part of British India is such as to present unrivalled means of ascertaining in the fullest manner all necessary facts relating to agriculture, but that those means have nowhere been completely utilized or made as efficient as they might be.' They then recommended that a system of local government should be appointed in each district, which would advise the local Government on all matters relating to agriculture and statistics, and superintend all measures designed to improve the agriculture of the country. The creation of imperial and provincial departments of land records and agriculture in and after 1881 was designed to fulfil the objects thus explained. The establishment of a scheme for the effective utilization in the interests of agriculture of information obtainable through the land records is therefore a primary duty of the directors of agricultural departments. The question was one of the most important discussed at the recent conferences.

2. The opening Resolution of 1881, in which the duties of the new departments were first described, explained that an examination of the Famine Commissioners' recommendations in connection with agricultural enquiry showed that their final object was to urge, as a practical outcome of an intelligent scheme of investigation, the policy of maintaining agricultural operations at the highest attainable standard of agricultural efficiency, that this policy included the prevention of deterioration as well as the attainment of positive improvement, that it was necessary, therefore, first to localize every agricultural

defect, then to discover its cause, and, finally, to devise such protective arrangements as may remove or alleviate its injurious action. As an important illustration of the character of the investigation which was to be made, the examination of each agricultural tract in respect to its liability to suffer from drought on the one hand, or the extent to which it was or could be protected from drought, on the other, was suggested. The whole scheme of investigation was afterwards briefly designated as 'district analysis'.

3 The form in which the programme of investigation was put forward in the 1881 Resolution and the special attention which was drawn to the desirability of mapping out the tracts of a province in relation to their liability to failure from drought led in some provinces to a misconception of the scheme. It was assumed that a general enquiry into the agricultural condition of each district made once for all, and a special investigation of the liability of each part of it to failure from drought, would meet the design of the Resolution. It was not clearly apprehended that the scheme was to be slowly and gradually worked out, that one by one every agricultural defect should be in the course of time closely analyzed and carefully studied with a view to the possible discovery of remedial action, and that for the purpose of ascertaining the existence and extent of each defect, the utmost use should be made of the information which the land records could be made to yield. Thus, while in many parts of India excellent reports, maps, and atlases were published in illustration of the general condition of each district, no precise enquiry was set on foot as to the agricultural circumstances of each village or group of villages; as to the particular defect or defects which prevented each locality from reaching 'the highest standard of agricultural efficiency', or as to the possibility of remedial action in each case.

4 The enquiries, however, that were actually made in some provinces threw much light on the position. They proved that, notwithstanding the hereditary experience of the Indian cultivator and the special knowledge which he possessed of methods and appliances suited to the locality in which his crops are raised, many defects do exist in the agricultural condition or system of almost every district which, if they cannot be altogether removed, can at least be considerably modified and lessened. At the agricultural conference of 1890 which met Dr. Voelcker before his report was written, the necessity 'of laborious investigation before we can trace out the causes which have stimulated development in some parts of India and retarded it in others' was pointed out, and the advantage of utilizing village records as a basis for detailed enquiry was urged. Dr. Voelcker's report went far to prove the existence of innumerable defects in agricultural conditions and practices, and the importance in many cases of an intelligent analysis of facts and statistics, and of well-organized enquiry from village officers. The conference which reviewed Dr. Voelcker's report in 1893 took the same view.

5 So matters stood when the subject was brought before the recent conferences for consideration and discussion. If

‘failure to reach of occasional, (2) it was to be the object of the whole scheme of enquiry to minimize agricultural distress and agricultural loss in each class of cases, and that the first step was to decide how far the land records machinery could be utilized in the investigations under each head.

(1) *Occasional failure* was explained as ‘sudden distress due to unforeseen calamity, such as failure of rain, hail, storm, inundations, etc., requiring, as a rule, immediate relief.’ In these cases the land records are of primary service to district officials as indicating the extent and character of the calamity. The functions of the director of the land records department are confined to organising or to suggesting how to improve the system under which prompt and continuous information supplied by the records should be brought before the responsible authorities and to ascertaining that proper effect is given to the system. It is left to the district officers to take suitable action. The examination which was made at the recent conferences of the measures which have been taken in the last few years to utilize the land records for this purpose proved that the system now established in every part of India in which land records are maintained is excellent, and that the results have already been most satisfactory.

(2) *Gradual failure* was explained as ‘gradual deterioration due to ascertainable causes requiring early and special measures of prevention and relief.’ Considerable distress had been known to have occurred in many parts of India in consequence of neglect to relieve the population of agricultural tracts which had suffered from cattle murrains, from swamping due to the interference of drainage by railway embankments or canals, from the growth of a noxious weed and from other causes which gradually reduce the value of land or affect the prosperity of the people. ‘In almost every province,’ it was written, ‘the detailed records now maintained under careful inspection by village officers provide, although in scattered forms and in troublesome detail, all the information necessary for indicating the serious deterioration of any agricultural tract, and it only remains to make provision for such a clear and simple abstract of the information and statistics embodied in the village registers as will enable district officers to grasp the pertinent facts without real difficulty or unnecessary waste of time.’

One of the most important results of the recent conferences has been the practical adoption of this plan. In every part of India,

figures kept up show at village, the year, and so on. It indicates at once whether a village or group of villages is declining in agricultural condition, and this fact known, the cause of failure can be ascertained and remedial action suggested. It is important

in the course of the Government of India that the recommendations, recorded in the proceedings of almost every conference should be adopted to the effect that the books should be periodically inspected by some responsible district official, so that within very few years the condition of every village should come under intelligent review, and that notes should be entered by the inspecting officer explaining the cause of any marked or serious deterioration, and of any suggestions made or action taken to meet the case. Independently of the advantages of the system for purposes of current administration the series of circle books thus maintained will form an historical record of great value to officers who may be hereafter called upon to revise the assessments of land revenue. Directors of departments of land records and agriculture should be instructed to consider it one of their chief duties to ascertain that the circle books are punctually and intelligently examined in every district. On the other hand, district officers should be required to communicate to the Director, for entry in his office ledgers, the proved existence of any serious agricultural deterioration that may have occurred in a locality.

(4) *Persistent failure* was defined as failure to reach the highest attainable standard, due to causes or defects of a more or less permanent character, and requiring prolonged investigation. Such causes or defects are, it was explained, want of irrigation, frequent liability to failure of rain, insufficiency in the wood or fuel supply, cattle disease, plant diseases and blights, want of drainage, the prevalence of saline efflorescence, gross imperfections in agricultural practices, the want of suitable manures, and so on.

C. It is to this class of cases that Mr. Vieltner's report chiefly refers. Many of the defects such as those enumerated demand scientific enquiry by experts inclining experimental investigations on the departmental farms or on the estates of the Courts of wards or of landlords willing to assist in the work. This branch of enquiry will be dealt with in the succeeding Resolution. But the land records and the land record establishments can often be utilized for providing a basis for more detailed enquiry. Thus, the distribution of irrigation, the character of the rainfall in each tract, the extent of the wood supply can be ascertained from the records themselves. Information as to the occurrence of particular cattle and plant diseases, the areas affected by the outbreak of salts, facts as to agricultural practices, and other agricultural matters can be attained by well-organized enquiry from the circle and village officers, to whom a series of questions bearing on the subject under investigation may be circulated.

7. These suggestions are sufficient to indicate the importance of the information which the land records and the land record establishments can under intelligent direction be made to yield. The plan of enquiry must, however, in each case be worked out by the director of the agricultural department with the assistance of the experts placed at his disposal, and whatever system be adopted, the work is one which in its broader aspects must extend over periods of many years. The necessity for detailed enquiries will

probably never cease. Whether in the working plan which is to be laid down enquiry at any one time should be limited to one or two subjects was a question which was discussed at the recent conferences, but will be dealt with in the succeeding Resolution. What the Government of India desire now to insist upon is that, whatever may be the agricultural defect which is brought under investigation, the officers of the agricultural department should, as a first step, consider how far the land records and the establishments maintaining them can be utilized for providing information necessary to the enquiry.

8. Although the relation of land record establishments to famine administration was not included among the questions placed before either the conference of 1893 or those recently held, it must not be forgotten that one of the objects with which the Famine Commissioners recommended the organization of those establishments as well as of the formation of provincial departments of agriculture and land records was in order that the administrative and executive officials responsible for dealing with famine might at all times have at their command both the fullest information regarding the condition of every agricultural tract and the people upon it, and in seasons of scarcity be provided with a well-organized agency through which, in the first place, continuous intelligence of the state of every village and every suffering person in it would be communicated to them, and, in the second place, direct relief could be in case of need administered under their direction. These first objects of the land record machinery were fully considered in the famine codes drawn up in 1882, immediately after the constitution of the new departments had been directed. Fortunately, since those codes were first issued no serious famine or widespread scarcity has until now afflicted the country, and time has been thus given to bring the establishments into good working order. Their utility has indeed been partly proved on the occurrence of sporadic distress in limited areas during the past 15 years. But full evidence of the immense advantages foreseen by the Famine Commissioners, resulting from the existence of a well-organized "intelligence department," has only been brought now before the Government of India.

9. The lay *notas* of the system in the division of the whole country into easily managed circles of 50 to 100 villages each. It has been estimated that in the temporary settled provinces there is at the present time at the disposal of the district officers an army of some 200,000 village officials who form a well-trained and disciplined rank and file, commanded by a staff of 3,000 or 6,000 circle inspectors, who may be well compared to the commissioned officers of regiments. The duties laid down for the latter in the famine codes and by provincial rules are that in ordinary years they should as already explained, provide the fullest information and statistics regarding the crops and agricultural conditions of every village,—a duty which in every province has in recent years been, so far as circumstances have admitted, well performed, and that in times of famine they should at frequent intervals visit every village

and, if necessary, every house for the purpose of ascertaining whether any person or persons are suffering from want of food or from sickness, whether relief is distributed in accordance with duties to be received, and whether private charity is encouraged and organized, that they should promote the employment of labour on agricultural operations, invite applications to construct wells and other agricultural improvements, make known the places at which relief works are opened, the nature of each work, and the classes of persons to whom such work is open, conduct the distribution of gratuitous relief to persons unable to leave their homes; report on the price of food, the state of the people and cattle, the condition of the water-supply; and generally bring to the immediate notice of the district officials any occurrence deserving attention. In the performance of these duties each circle inspector has, to aid him some 20 to 40 village officers.

10. Under the stress of the present calamity by which so many provinces of the empire are affected, the services of the land record establishments have proved of the greatest value, and have materially reduced the difficulties which on former occasions of famine resulted from the absence of organized machinery.

FOURTH RESOLUTION.

SCIENTIFIC AND NATIONAL ENQUIRY UNDER IMPERIAL DIRECTION.

It has been briefly explained in the prefatory Resolution of this series that the responsibility for maintaining and developing a 'national scheme of agricultural enquiry' devolves primarily upon the imperial department of revenue and agriculture. The term 'agricultural enquiry' must here be understood in its widest sense. It must be interpreted to include investigations in all branches of science which bear directly or indirectly on agricultural interests and on the development of the products of the soil, and the word 'national' must be held to apply to all enquiry which cannot, for sufficient reasons, be conveniently confined within geographical or administrative boundaries. The national scheme of agricultural enquiry thus explained embraces, so far as it has up to the present time been developed, the following sciences or fields of investigation:—

- | | |
|--------------------------------|--------------------------------------------------------------------------------------------|
| (1) Geography . . . | Represented by the Survey Department |
| (2) Geology . . . | By the Geological Department |
| (3) Meteorology . . . | (Including solar, magnetic and astronomical observations) by the Meteorological Department |
| (4) Botany . . . | By the "Botanical Survey of India" |
| (5) Economic Products . . . | By the Department under the Reporter |
| (6) Veterinary Science . . . | |
| (7) Bacteriology . . . | |
| (8) Agricultural Science . . . | By the Department of Agricultural Chemistry |
| (9) Entomology . . . | By the National Museum at Calcutta |
| (10) Statistics . . . | By the Statistical Department |
| (11) Forestry . . . | By the Inspector General of Forests |

2. The chief considerations which justify the maintenance of imperial direction over investigations conducted in the fields of enquiry summarized in the preceding paragraph will be briefly noted.

The *first* consideration is that scientific investigations must, with few exceptions, be national and not provincial,—in other words, that scientific research cannot, as a rule, be confined within administrative boundaries. In 1890 it became necessary to point out to the Secretary of State how the system of provincializing investigation in the field of botany 'had led to the curious restriction of research to special localities or provinces, while others, forming in the aggregate the larger section of the empire, had been left without investigation of any kind.' But inequality of results is not the only defect which results from confining scientific enquiries to separate provincial action. The unnecessary duplication of labour is another and perhaps more serious defect for

example, the economic products of two adjacent provinces are to a material degree the same, the exceptions forming but a small percentage of the whole. A cattle morbill, again, may be due to identical causes throughout India. It would be a waste of labour that simultaneous enquiries should be made by scientific experts as to the botanical character of the same plant in two contiguous areas or epidemic should be sought for y provincial centre. Such no place for at least a group of provinces.

The second consideration is the importance of securing first class experts for purposes of scientific research. The value of results depends mainly on the competence and qualifications of the investigator especially in a country in which conditions vary much from those prevailing in Europe. In view of this circumstance and of the financial impossibility of providing every province with a staff of first class and highly paid experts in each branch of scientific research, it becomes necessary to place scientific investigation, as a rule, under central direction.

The third consideration is that scientific investigation must be conducted on the basis of a well-considered working-plan. The development of the scheme cannot be entirely left to the occasional and partial initiation of individual governments. In the despatch of 1890, already quoted, it was shown that the distribution of scientific research has hitherto been unequal, both in relation to the sciences represented and to the areas covered by it, partly because no authority had been made responsible for initiating research in new fields, and partly because action taken in one province had not been taken in others. Systematic botany, for instance, in some provinces, and systematic geology throughout India, have been strongly represented for a long series of years, whereas the study of the useful and economic products of the country and the practical investigation of minerals had until very recently been neglected, while in some of those fields in which modern science has in recent years been working in Europe, such as for instance that of bacteriology, research has hardly commenced.

3. In accepting the responsibility for the general direction and control of the scheme of national research, the Government of India have no desire to exclude the co-operation of local Governments and Administrations. They would, on the contrary, wish to obtain their advice and assistance at every important step that may be taken towards the development of the scheme, and to receive for favourable consideration any suggestions for initiating or extending scientific research, of which the importance may be shown. Nor will they refuse, whenever circumstances may admit, to transfer any expert attached to an imperial department to the temporary or partial control and direction of the provincial authorities. Effect has indeed in recent years been given to this policy by placing officers of the geological and botanical departments for a definite period under the orders of a local Government and again by arranging that the services of certain officers of the meteorological department

should be shared by the imperial and provincial authorities. Thus the national character of the scheme of research does not altogether preclude provincial independence and co-operation.

4. In 1881, when the orders of Her Majesty's Secretary of State were received for the creation of agricultural departments upon which the responsibility of organizing a scheme of enquiry was to be placed, the position was found to be this.—Geographical department of
ed staff of im-
onfined to Ben-
gal and the North-Western Provinces. A meteorological department comprised one imperial officer and four officers partly imperial and partly provincial. Astronomical, magnetic and solar observations were shared by Madras, Bombay and the Government of India. Forestry was represented by provincial and imperial departments. No other science found a place in the scheme. Since 1881 material expansion, sometimes of the investigating staff, sometimes of the programme committed to them, has been effected. A brief account will now be given of the measures which have been taken for the development of enquiry in each field of investigation since that year.

5. *Geography* was in 1881 represented by a well equipped and important survey department, of which the cost to the State considerably exceeded 20 lakhs a year. The programme which it had undertaken was a large one, and may be briefly described as the trigonometrical, the topographical, and the cadastral surveys of India. In 1881 the first of these great surveys had almost approached completion. Considerable progress had been made in the second, while the third was shared with local Governments, each of the presidencies, for instance, having separate cadastral departments of a professional character. At the same time the recently introduced policy of financial decentralization augmented the tendency in many provinces to effect cheap cadastral surveys with non-professional establishments, thus entailing a danger that the provincial maps could no longer be accepted for embodiment in the geographical charts of the professional department.

Previously to 1881 financial considerations had required that imperial expenditure on geographical survey should be reduced. An immediate limit of 20 lakhs had been laid down. But the sudden reduction of a long established service was found impossible, and shortly after 1881 the alternative was adopted of diverting a large portion of the staff from unremunerative to remunerative work. The latter was found in the detailed surveys of forest and purpose local Governments were in- parties to lay down for each district be scientifically connected with the

three principles. Partial effect was given to it in the North-Western Provinces, Burma and Assam. Nothing could be done in provinces in which, as in the Punjab, cadastral maps were approaching completion by a well-trained local agency, but, on the other hand, in provinces where the local agency had not been trained, much of the field plotting itself had to be done by the professional surveyors.

The advantage to geographical science of the system adopted is that wherever the field maps have been thus professionally connected with the trigonometrical stations, new topographical details, entered from time to time as changes in the features of the land surface may require in the field maps, can be at once transferred to the geographical charts.

Simultaneously with the development of the large geographical scheme as represented by the three important branches of survey, other scientific work, in hydrological observations, latitude investigations, and cartographical development, has been carried on by experts of the department.

In the meantime the staff of the imperial department has been gradually reduced, and will, as the demands on it diminish, be brought under further contraction. At present the recent annexation of Upper Burma, the development of the North-Western frontier, the opening of a cadastral survey in Bengal, the new requirements of forest departments and the uncompleted portion of the topographical scheme in the other provinces, form an extensive programme, for the execution of which large establishments are still required.

6 *Geology* has for many years past been represented by a strong corps of experts which, till 1881, was mainly devoted to the scientific examination of rocks and strata. After 1881, the policy was introduced of directing the attention and labours of the geological officers also to practical investigations. In 1893, the department was reorganized. Scientific exploration was, as a basis for the study in detail of the mineral resources of the country, still to hold the first place but a small section of the officers employed, including, whenever required, experts imported for temporary employment, was set apart for the special examination of mineral fields. Changes were made in the rules under which recruits admitted into the department were required to undergo practical training in mines or in laboratories. At the same time the principle of decentralization was so far adopted as to admit of the services of a geological officer being temporarily transferred for sufficient reasons to any provincial Government. Recently an inspector of mines has been attached to the department.

7 *Meteorology* was, in 1881, represented partly by an imperial and partly by provincial departments. The Famine Commissioners laid much stress on the promotion of meteorological enquiry. It was, they wrote, of primary importance that meteorological observation should not only be maintained in complete efficiency, but also so strengthened and improved as to ensure the early and punctual supply of information to officials and to the public of weather conditions and prospects. Protection against famine, the safety of

shipping, warning against floods, were objects to be held in view. Since 1881 the department has been materially strengthened. A second European expert has been attached to the central office. A complete system of warning signals has been established along the coasts. The number of observing stations has been considerably increased inland. Information is brought by telegraph from 116 instead of as formerly from 50 of the principal stations, detailed statistics illustrated by charts are daily despatched by post, and an abstract of them by telegram, to every part of India. The character and causes of meteorological phenomena which occur on the continent or on the adjacent seas are being carefully worked out.

The provincial officers, who have other local duties not connected with meteorology to perform, conduct their meteorological work in co-operation with and under the general guidance of the central department and furnish the local Governments with such supplementary details as they may require.

8 *Botany*, like geology, is a science which has been officially represented from the earlier years of the century. But, as was long the case with the other sciences, it was not till the middle of the century that it came to the field of systematic and naming of species. In the early part of the century any and the economic and agricultural uses of plants were not made the subject of organized enquiry. As systematic botany was at one time a favourite occupation of most men with scientific training and tastes, much had been done independently of official agency by medical officers and others in many parts of India. But no organized scheme had ever been worked out for the whole country. In 1881 two officers, one at Calcutta and one at Saharanpur, were officially engaged on completing the botanical survey of Indian plants, but their labours were practically restricted to the two provinces of Bengal and the North-Western Provinces in which they were located. In 1885 a third officer was, at the request of the Government of Madras, attached to that Presidency. Thus, of all India, only three provinces were included in the area of botanical enquiry.

In 1890 the Government of India, in communication with the Kew authorities, expanded the scheme of botanical investigation. The Calcutta officer was placed at the head of a 'botanical survey of India,' the entire empire was, for the purposes of the survey, divided between the three experts, with the occasional assistance of a fourth in Bombay, botanical investigation was to take, as far as possible, a practical direction, and the officers of the provincial departments of agriculture were to co-operate with the botanical officers in arranging working plans of enquiry.

Whether in view of the needs to be met in other branches of scientific investigation the staff employed on the botanical survey of India can always be maintained at its present strength, is a question which is still under consideration.

9. The *economic products* of India had not previously to 1881 been brought under systematic investigation. Much scattered information had been embodied in official and private publications, in

scientific journals and the like, but was of little practical use, because it had not been collated and published in any accessible form. Advantage was, therefore, taken of the various requisitions made for collections of the products of India, on behalf of a series of international exhibitions ending with the Indo Colonial Exhibition of 1884, to allot to an expert official the duty of making a full collection for all India illustrated by a *catalogue raisonné* which has recently been completed and published as a 'dictionary of the economic products of India'. The work has occupied 10 years. In 1887 the appointment, hitherto a temporary one, was made permanent. The collections were placed in the national museum at Calcutta, and the officer holding the appointment, whose duties had been pending the completion of the dictionary, confined to the collation of material already received, is now engaged in making supplementary investigations regarding these economic products in respect to which information is wanting or incomplete.

10. *Veterinary science*.—This includes the investigation of animal diseases, and of the means by which they may be prevented or cured. The enquiry is one of great importance to agricultural industry. The annual loss due to animal disease has been estimated to exceed of rupees. It has indeed been officially stated by the local Government of one of the northern provinces that in the course of any five years the destruction caused by rinderpest alone was greater than that caused by drought.

Up to the year 1891 the only step taken towards serious investigation was the appointment in 1868 by Lord Mayo's Government of an important Commission whose report fully confirmed the necessity of further enquiry and of well organized measures. No further action, however, was taken until 1890, when proposals were sanctioned by Her Majesty's Secretary of State involving the attachment of a veterinary officer transferred from the military staff to every province and of two officers with central duties to the imperial department of revenue and agriculture. A scheme was then drawn up for a so-called veterinary survey of cattle and of cattle diseases. The survey is primarily directed by one of the imperial officers who is engaged with the co-operation of the provincial officers in collecting and collating information throughout India regarding the various breeds of cattle and other animals useful to agriculture in the country and of the diseases to which they are subject.

11. *Bacteriology*.—Simultaneously with the veterinary survey investigation is being made as to the possibilities of preventing or curing cattle disease. The treatment of many diseases is known and veterinary schools under the direction of the provincial officers have now been established at almost every provincial centre for the instruction of native practitioners. A lead in this direction had indeed already been given in Bombay, the Punjab and Madras. But no successful method of dealing with the most fatal and destructive epidemics, such as anthrax, rinderpest, and surra—a disease confined to hot and moist climates—had yet been discovered. Three possible systems of dealing with them had, from time to

time, been suggested which may be summarized as extermination, segregation, and inoculation. The first of the three, extermination of diseased or suspected animals, is the method in which most confidence is placed in European countries, but, owing to religious prejudices, is impossible in India. The second, segregation of infected animals, cannot be effected without legislative measures and a large staff of inspectors or police. Various proposals have since 1881 been submitted to the Government of India for legislative action, but have been, with the general concurrence of all local Governments consulted, condemned in view of the harrassment to the people and the great expenditure to the State that they would entail. The third measure, inoculation, which demands bacteriological investigation, is, therefore, the only preventive measure that may be possible, except indeed in those cases in which medicinal cures can be discovered. In this view the services of a competent expert, Dr. Lingard, were obtained from home, and a bacteriological laboratory was established at Poona. The climate, however, not proving favourable for laboratory investigation, the institution was transferred to a colder site in the Himalayas. In the meanwhile the character and causes of the destructive epidemic, known as *snorra*, of which the wide distribution had not hitherto been suspected, and which is due to a blood parasite, of which the life-history could be worked out in any climate, were investigated by the expert at Poona, and the valuable results of his researches have already been published.

The Government of India is now considering the desirability of strengthening, by the addition of a second expert, the bacteriological staff attached to the Himalayan laboratory. Rinderpest, which was declared by Lord Mayo's Commission to be more destructive than all other diseases put together, and which is suspected to be probably amenable to vaccination, will be the primary subject of investigation. The enquiry is one to which special importance is attached, in view of the fact that it can only be conducted in a country in which, like India, the slaughter of suspected animals is not compelled by law. The discovery wherever made of an effective vaccine for rinderpest would, therefore, be a boon to every country in the world.

12. *Agricultural science* is a field in which provincial, as contrasted with national enquiry, can be usefully carried on. Indeed most of the work must be done by local observers and experts. Nevertheless it was deemed that, as urged by a conference of provincial officers in 1885, the services of a first class agricultural chemist of European reputation as an investigator of many difficult problems of importance connected with soils and cultivation throughout India, would, if attached to the imperial department, be of considerable use. His main duties would be, in consultation with provincial officers, to co-ordinate scientific investigations, to initiate enquiries, to construct working-plans for provincial farms, and generally to guide with his advice the course of experiment and to preserve continuity of action. He was intended indeed to be little more than the professional advisor of provincial departments.

with the officials of provincial departments of agriculture, and by whom, under the direction of the Trustees, a great deal of valuable information as to the character and distribution of insect pests has since been collected and published. The importance of prosecuting such enquiries with vigour under competent experts has been urged at many of the recent conferences, and the question of expanding the scheme of investigation with the view of covering the whole ground of enquiry is under the consideration of the Government of India.

The subject is one which has received considerable attention in the United States under the direction of the Washington agricultural bureau, and it is satisfactory to learn from the reports published by the Indian museum officer that many of the entomological enemies to agriculture are common to India and America, and have been more or less successfully combated to the mutual advantage of agricultural interests in the latter country. Practical results ought, therefore, when the agricultural community are sufficiently educated to accord their co-operation, to be quickly achieved.

be said now to be experts, and for the most part their scientific investigations are carried out under the direction of the local Governments whom they serve. On the other hand the education of the European officers in the science of forestry is provided for at a college supported by the imperial Government in England, and of the native officials at a national school directed by an imperial officer in India. All schemes for the management and development of provincial forests technically called 'working-plans' are in their scientific aspect scrutinized and corrected by imperial officers, and the forests themselves are periodically visited by an imperial Inspector General with a view to the guidance of the executive officials in the scientific investigations which are to determine the character of the trees adapted to each locality and climate and the appropriate treatment of them. Finally, it is the task of the Government of India to formulate, in consultation with local Governments and the imperial experts, the broad principles upon which the scheme of investigation and development is to be based.

10. The share in the national scheme of the agricultural enquiry which devolves primarily upon the imperial authorities has now been explained, the measures taken, since the new department was created in 1881, towards the expansion and promotion of enquiry under central direction have been indicated. There are still many defects in the general scheme. It is still unequal and incomplete. What may be termed the older sciences—geography, geology, and botany—continue, for instance, to receive a disproportionate share of the State expenditure devoted to scientific enquiry, while the newer sciences which comprise researches into the life of animals and plants. Long standing departments have profited by the traditional respect which has been paid to them. Those of more recent birth have had to struggle for recognition, and against the opposition of the older branches. The Government of India has now under consideration the question of equalizing the claims of each branch of science, and in the

intelligent advice of the provincial departments of agriculture. Already in the proceedings of the recent conferences the Government of India is pleased to observe that strong recommendations have been recorded in favour of promoting active research, in connection with the nature, prevention, and cure of plant diseases due to insect pests and other more obscure causes. So, too, at the agricultural conference of 1893 a request was made that botanical investigation might be made to take a more practical direction. Appeals such as these for the extension and development of scientific enquiry from

those who have the opportunity of field duties the real needs of the Government of India in developing the scheme of investigation in right directions and strengthen their hands in organizing on a sound basis a staff of scientific investigators.

13 But the duties of agricultural departments will not end here. The officers of the departments should take every opportunity of working out, in conference and personal consultation with the expert investigators, a plan of operations, and of assisting them in obtaining the facts and statistics which they may require. Thus in the case of botany they should explain to the botanical expert when he visits or is invited to the province further of -

may be taken in the case of minerals in consultation with the geological officers. Again, they should make themselves acquainted with the measures being taken by the veterinary officers for the survey and study of cattle disease, and should assist them in obtaining the information which they may wish to collect from agriculturists. They should bring to the notice of the reporter of economic products any facts and details which are likely to be of interest to him and supply him freely with information under all his office.

It may be desirable to give notice of the forest land to the administration of the land, and should assist them to devise useful schemes by which requirements may be met. Above all, they should take the utmost advantage of the advice and guidance of the agricultural experts attached to the imperial department whose services have been freely placed at their disposal by the Government of India, and who themselves stand in need of the local knowledge and special experience which only the provincial officers possess.

If during the next few years the active and intelligent co-operation of the provincial officers is thus accorded to the various departments and experts who are engaged in the investigations which directly or indirectly are required by agricultural interests, the Government of India are assured that, with the advice and assistance of local Governments and Administrations, they will be able to effect material progress in the great national work of scientific research.

FIFTH RESOLUTION.

SCIENTIFIC AND LOCAL ENQUIRY UNDER PROVINCIAL DIRECTION.

1. It is important to bear in mind that the creation of agricultural departments in India has been due to the occurrence of famines. The Commissions appointed on the occasion of two serious famines, in 1866 and 1873, to advise the Government on the action to be taken for the mitigation of distress caused by failure of harvests in the future, recommended, as a principal measure, for the institution of a system of local enquiry, which would lead to the gradual improvement of the agricultural system and to the greater prosperity by which so many parts of the empire have, in the present year, been afflicted brings renewed importance to the main object for which agricultural departments were designed, and imposes fresh responsibility upon all local Governments and Administrations to give the fullest possible effect to the policy advocated, a policy which was explained in the Famine Commission's report of 1880 in the following words —

‘Our report,’ they wrote, ‘has clearly shown how greatly agriculture predominates over all other interests and employments in which the people are engaged; how essential we think it that technical agriculture should be encouraged, and that the power of the soil to be improved should be increased, and that the wealth of the country should be added to the wealth of the people, and that the supply of food should be increased, and that the population should be kept pace with the increase of the population.’

2. In the opening Resolution of 1881, in which the programme of the new department constituted was set forth, the Government of India endorsed this view; they explained that the chief object of the new department was to improve the agricultural departments by the Famine Commission, and that the highest object of the department was to improve the agricultural departments by the Famine Commission.

intelligent advice of the provincial departments of agriculture. Already in the proceedings of the recent conferences the Government of India is pleased to observe that almost every subject which has been recorded in connection with the nature,

insect pests and other more obscure causes. So, too, at the agricultural conference of 1893 a request was made that botanical investigation might be made to test the

observing in the course of their field duties the real needs of the agricultural community will at the same time assist the Government in the line of investigation in right directions in organizing on a sound

13. But the duties of agricultural departments will not end here. The officers of the departments should take every opportunity of working out, in conference and personal consultation with the expert investigators, a plan of operations, and of assisting them in obtaining the facts and statistics which they may require. Thus in the case of botany they should explain to the botanical expert when he visits or is invited to the province in what directions

locality. Similar action may be taken in the case of zoology. In consultation with the geological officers. Again, they should, at a general meeting, acquaint themselves with the measures being taken to secure the services of veterinary officers for the survey and study of cattle diseases. They should assist them in obtaining the information which they may require, and collect from agriculturists. They should bring to Voelcker and the reporter of economic products any facts and details of which he is likely to be of interest to him. In connection with all these branches of work for him to publish, they should assist the officers or of the authorities. They should also land the needs of the selected officers and experts from all the departments may be met. In 1893 to discuss the measures for the advantage of the Government of India were thus been selected and

to formulate the principles upon which agricultural reforms advocated by the Famine Commission should be attempted. In order to ensure the successful execution of these reforms the Government of India is in a position to assist upon which the provincial departments of agriculture

results which have been recently noticed by the local Government. Land 'which was mostly a net-work of ravines affording grazing of the poorest description' was experimentally enclosed as a fuel and fodder reserve. An expenditure of Rs. 3,000 has at the end of 10 years brought in an annual income of over Rs. 1,000 from the wood and grass raised in what had been, as Dr. Voelcker observed, simply waste-land. There are, it is believed, several hundreds of square miles of waste ravine lands on the banks of the large rivers of Northern India, of which the reclamation would be of material advantage to agricultural interests, and the success of the experiment has already led to the extension of the system in similar tracts.

(4) One more example may be given of material financial results obtained by investigations conducted on a scientific basis under official direction. Between 1870 and 1880 careful field-to-field enquiries were made in the North-West Provinces and later on by the agricultural and canal departments in the Bombay Presidency as to the cost of applying canal irrigation to cultivated land. These have led directly and indirectly to an improvement in the canal revenue of something like thirty lakhs a year not only without detriment to, but with distinct advantage to, agricultural interests, in view of the fact ascertained in both Provinces that the lavish use induced by unduly low rates of canal water on unmanured land leads to its deterioration.

These illustrations will suffice to indicate that important financial and agricultural advantages can be secured by experiments and investigations intelligently conducted under official direction. But they also show that the controlling officials must be assisted by competent experts, that continuity of intention and effort is necessary, that occasional success can only be obtained amid many failures, and that a long period of years is required for the definite ascertainment of positive results.

6 The Famine Commissioners strongly insisted on the necessity of employing, under the general direction of the provincial departments of agriculture, competent experts trained at home. 'There must,' they wrote, 'be employed a certain limited number of persons possessing superior technical and scientific knowledge of practical agriculture whose task it would be to aid the Government in its endeavour to introduce improved methods of cultivation. These should be trained specialists, and their number might probably be at the rate of two or three to a province, and in all cases should be allowed by a year of practical training to be sent out to India.' The consideration is essential that a grant should be provided with a view to the possibility of their attending agricultural colleges in the lifetime of a European. Dr. Voelcker and by Mr. Voelcker advised that the training should be through a training school such as that given at Cirencester or similar institutions followed

5 (1) In 1877 a conference attended by officers of the geological and of the revenue and irrigation departments of more than one province, of whom two were the late and present secretaries of the imperial department of revenue and agriculture, was held in a district of the North West Provinces for the purpose of discussing the possible methods of reclaiming lands rendered unculturable by an excess of salts. There are in various parts of India and especially in the north, several thousands of square miles of lands thus excluded from cultivation. An elaborate scheme of experiments, including flooding, drainage, the application of chemical and other manures, and various methods of agricultural treatment was laid down by the conference, and was carried out by experts of the agricultural and irrigation departments. After some years, a system of treatment, within the reach of any enterprising agriculturist, was developed which admits of the profitable reclamation of saline lands hitherto condemned as unculturable. Although the widespread extension of the process of such profitable reclamation cannot be expected until the land owning classes have been so educated as to take spontaneous interest in the work, yet the results obtained have proved that a material addition to the cultivated area of the country can, in the course of time, be made, and that saline land once thoroughly reclaimed may be made capable of producing excellent crops. It is estimated that every hundred square miles that can be recovered will if, as is often the case, the land is within reach of the canals, produce annually upwards of a million of maunds of food grains.

(2) In Bombay the Agricultural Department undertook the introduction of European methods of manufacturing dairy produce. A Swiss expert was imported and experiments were set on foot. The following account of the results is given in the proceedings of the recent conference held in the Bombay Presidency: 'No enquiry was necessary to prove the superiority of the English and continental methods. What was essential was to popularize the improved methods and teach the use of improved machinery. Local dairies were established at Poona and Bombay. The demonstration was successful and as success was secured the departmental dairies were closed. Up to date about five lakhs of rupees worth of improved dairy machinery has been imported and the improved methods have

temporary transfer

of the Swiss expert to the North-West Provinces, where within two or three years he was established on the very saline lands which were visited by the conference of 1877 and which have been since converted into a profitable dairy farm whence dairy produce is now exported to Assam, Baluchistan, and other remote parts of India.

(3) Another experiment, initiated in 1885 at the instance of the Agricultural Department in a district of the North-West Provinces, and referred to in Dr. Voelcker's report, has borne fruitful

results which have been recently noticed by the local Government. Land 'which was mostly a net-work of ravines affording grazing of the poorest description' was experimentally enclosed as a fuel and fodder reserve. An expenditure of Rs. 3,000 has at the end of 10 years brought in an annual income of over Rs. 1,000 from the wood and grass raised in what had been, as Dr. Voelcker observed, simply waste-land. There are, it is believed, several hundreds of square miles of waste ravine lands on the banks of the large rivers of Northern India, of which the reclamation would be of material advantage to agricultural interests, and the success of the experiment has already led to the extension of the system in similar tracts.

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... should be at the rate of two or three to a province, and in all cases should be allowed by a year of practical training in India.' The consideration is essential that a person so trained should be provided with

... of their ... Euro- ... and by the agricultural conference of 1893. Dr. Voelcker advised that the expert assistants employed 'should have passed through a training such as that given at Cirencester or similar institutions followed

' up by—and this is essential—subsequent practical experience on ' a farm ' The reservation he added, as ' to practical experience is, in ' my opinion, so important that it constitutes my reason for advocat- ' ing the employment, at first at any rate, of European rather than ' native assistants, though it is quite possible that natives will ' occasionally be found with the necessary qualifications ' The con- ' ference of 1893 endorsed this view in a resolution to the effect ' that

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' sufficiently well trained and qualified are available, he should be a ' European expert ' They further urged that the expert should be supplemented by a staff of native assistants trained in this country, and that suitable institutions should be established for their education. The conferences recently held have in all the larger provinces supported the recommendations of the conference of 1893.

7. Influenced by this strong consensus of opinion, the Govern- ment of India have arrived at the conclusion that the time has now come when in every province in which no such arrangements have yet been made, a definite scheme should be drawn up under which a strong and efficient staff of agricultural experts will be within a limited period placed at the disposal of the provincial department of agriculture, and that, as recommended by the conference of 1893, unless and until natives sufficiently well trained and qualified are available the staff should include a European expert They are aware that the present moment is one at which no avoidable expenditure on new establishments can be immediately proposed, and that they must at present be satisfied if a programme is arranged, with due deliberation and regard to future requirements, to be carried out as soon as circumstances admit But the very cause of present financial difficulties, famine, is in itself, as the Commissions of 1866 and 1878 have indicated, the strongest argument which can be used in favour of expenditure as soon as financial pressure is relieved of which the main object is increase of the food supply, while the few illustrations which have been given of the financial and agricultural advantages which have already followed intelligently directed experiment, indicate the remunerative character of the outlay which will be incurred, and the increasing protection which will be afforded thereby to the agricultural community against the difficulties and distress in the seasons of failure which must inevitably occur from time to time in future years.

8 These observations do not apply with equal force to all provinces In the two presidencies of Madras and Bombay, for instance, the measures already taken or contemplated for the equip- ment of the agricultural department are possibly adequate, while in the two provinces of Burma and Assam, where agricultural condi- tions are of exceptional character, and where rice is the staple pro- duct, action is not so urgently called for as in other parts of the empire But the Government of India desire to be informed by every local Government and Administration what, in their opinion,

will be the full staff of agricultural experts and assistants which should, when circumstances admit be placed under the control of the provincial department, in order to enable it to efficiently prosecute its primary and most important duty.

2. The employment of European experts and a trained staff of assistants involves the establishment of experimental farms. On this subject nothing has been recorded in the proceedings of the recent conferences which affects the opinion of the Famine Commission and of Dr. Voelcker that 'experimental enquiry conducted by means of experimental farms is a necessity in India for the development of agricultural improvement.' To what extent experimental farms should be multiplied in any one province is a question which it must be left to each local Government to decide from time to time as the scheme of agricultural experiment is developed. 'The decision must' writes Dr. Voelcker 'be partly based on considerations of expenditure and staff but the main consideration should be whether there is anything definite to learn, a particular question to solve, and whether this has any relation to the agriculture of the country around.' In the meantime the Government of India have no hesitation in requiring that the definite scheme for which they have called should include at least one central experimental farm adequate both in area and in the staff with which it is equipped to ensure the conduct of experiments on the system advocated by Dr. Voelcker.

10. It has been frequently urged that a single experimental farm in a large province is on account of the varying character of soil climate purpose of it

ability of parts of the province, or for bringing useful results to the agricultural community of various districts. It was partly for these reasons that Dr. Voelcker advocated the establishment of

'demonstration farms' in which the results of useful and The Government of time when native gentle-well designed system of fusion of experiment and general education was more than that there trust that in the the opportunity to overnment manage improvements. This

and prudent landowner would act in respect to us by utilizing the results of science and adopting any well tested and clearly demonstrated improvement in methods of farming. The Government of India have been pleased to observe that prominent attention has recently been called to this opening for the expansion of agricultural reform by the Lieutenant-Governors of Bengal and of the North West Provinces and they desire that the directors of the provincial departments and managers of estates under official control may in every province be required to give their earnest and

continuous attention to this plan of developing and testing all agricultural experiments which have in them any reasonable chance of possible success.

Where estates under the management of Government officers are not available, it may be desirable to consider Dr. Voelcker's suggestion of the establishment of demonstration farms

11. The system on which experimental and demonstration farms should be conducted has not been examined at any of the conferences which have been held, nor in the opinion of the Government of India could any precise recommendations have been usefully formulated for general guidance. Dr. Voelcker's chapter on the subject offers many useful suggestions which should be carefully considered by the agricultural staff responsible for the conduct of experiment, but it must be left entirely to the officers of the provincial departments to decide, in consultation with the imperial chemist, what the detailed arrangements should be

It is natural that these should differ in each locality. But there are certain broad principles noticed by Dr. Voelcker to which prominent attention may be drawn. The *first* and most important is the necessity of a working-plan which, as in the case of forests, must be continuously maintained and, unless for strong reasons sanctioned by the director of the department, not interfered with until the experiments once set on foot have yielded definite results. The *second* is 'that the issues in each case should be simple, and that the object of an experiment should, as a rule, be the only varying factor involved in it, in other words, that an experiment should be uniform and general information.

The framing of the working plan and the system on which results should be reported are matters which should be arranged in consultation with the imperial officer who has been placed, with this object, at the service of the provincial departments.

12. When in any province the department of agriculture has been equipped with a European or equally competent expert, with a staff of trained assistants, and with an experimental farm or farms, a programme or working-plan will be formulated not merely, as above directed, of the experiments to be carried out on the farms, but also of the defects in experimental

report, gives a long list of *prima facie* defects, to which the attention of agricultural departments should be directed, and it is known that many others exist to which Dr. Voelcker made no reference. The question how these should be dealt with has received prominent attention at the conferences which have recently been held and the general conclusion arrived at has been that it would be desirable,—*firstly*, that a cursory enquiry should be made which, by the examination of the agricultural system in a few typical districts, would indicate roughly the most important defects for the

removal or minimizing of which remedial action is required; *secondly*, that when this had been done, enquiry and experiment should be concentrated for a definite period on a very limited number of 'defects'. It was generally agreed that, though exceptions to this course might be occasionally made at the discretion of the director of the department, it would be found embarrassing to enter upon a campaign at one and the same time against all the various evils known or suspected to interfere with agricultural prosperity. This view commends itself to the Government of India who, while not desiring to restrict the power of the agricultural departments to expand their field of enquiry for good and sufficient reasons, think it desirable that local Governments and Administrations should understand that His Excellency the Governor General will be satisfied to know that at least one prominent agricultural defect is being subjected to searching investigation and experiment in each province.

13. The adoption of this view renders it inexpedient for the Government of India to attempt anything like a review of the numerous recommendations contained in Dr. Voelcker's report for the improvement of agricultural conditions. Taken one by one, the subjects with which his report and the proceedings of the 1893 conference deal will occupy the attention of the agricultural departments for very many years to come, and each subject must be carefully studied by itself in all its bearings at the time when it is taken up. given in the succeeding paragraph 'agricultural defect' and the action needed in dealing with it.

14. The order in which defects should be selected for successive enquiry and experiment will depend on the conditions prevailing in each province and must be left to the discretion of the directors of the provincial department under the orders of the local Government. But the Government of India may point to one subject which, in view of its important and universal bearing on the agricultural outturn, they deem to deserve special attention in every part of the empire and which, if no reason to the contrary exists, they would be glad to see taken up as the first subject of enquiry in all provinces. The subject is this. In other oriental countries well as in the western countries provided by cattle and other or solid, strictly conserved. in the way of preventing the latter from being used as such, but the former or liquid manure is mostly allowed to run to waste, and the practice of securing it for the fertilization of the field is hardly known. The results of scientific experiments in America have, however, indicated that the productive value of the liquid is even greater than that of the solid manure and lead to a conclusion that the utilization of the former would very materially increase the food supply of the country. The defect may then be thus defined — 'a neglect to use a highly valuable manure which is within easy reach of every cultivator.'

19. Subject to these considerations the discretion of the departments to expand the field of enquiry and experiment need not, especially in those provinces where an adequate staff of experts and assistants has been provided, be restricted by any absolute rule. It would not indeed under any circumstances be desirable that the investigation of a single subject, such as that offered as an exemplar, should be carried to the end before a new question is taken in hand. The time and attention which each subject demands must necessarily be greater in the first year or two of enquiry than in subsequent years when the most useful lines of experiment have been determined. What the Government of India do wish to

them.

20. In conclusion it must not be forgotten that an important provincial agricultural officer himself. This officer in the first part of their report, he chosen for his knowledge of the condition of the people and particularly of the agricultural classes, while in the second part they advised that a certain number of officers should receive a preliminary training at home before going out to India, and that meanwhile any officer selected should be allowed to spend a year or some longer period at a school of agriculture in Europe. The Government of India granted this last permission, of which advantage was taken in two provinces, and in 1889 local Governments were asked to offer their opinion as to the manner in which junior officers could be best trained in future so as to secure a succession of efficient officers to an appointment which requires technical knowledge and special experience. The replies that were received

of the Government seems, however, to be no doubt that in some provinces questions of agricultural improvement have been too greatly subordinated by the director to land record work, and that, as suggested by Dr Voelcker, the Agricultural College is necessary for the qualification

its trained assistants, the general they think, be left to a carefully selected officer who has shown aptitude and inclination for the class of duties which the superintendence of the department involves.

They are not, however, assured that in all cases sufficient consideration has hitherto been given to the agricultural side of the departmental programme in the choice of the officer to whom the control of the department is committed, nor, as suggested by Dr. Voelcker, that progress in agricultural enquiry and experiment has not been hindered by too frequent changes in the incumbency of the appointment.

21. Akin to this important matter is the question placed before the recent conferences whether with a view to their co-operation in the development of agricultural enquiry and improvement the training of junior civilians could not be improved, and in one province—Bombay—in which considerable consideration has been given to the subject, it was suggested through a short course at an agricultural college, which they might at least learn the general agricultural system which prevails in it. The question is one which deserves the consideration of local Governments and Administrations. Among those who are engaged in agricultural work, it is of special importance, too, that now that settlement operations are coming under contraction, some steps should be taken to ensure the better qualification of a certain number of officials to co-operate in the scheme of agricultural enquiry. On this subject the Governor General in Council invites the further opinion and views of all local Governments and Administrations.

SIXTH RESOLUTION

AGRICULTURAL EDUCATION.

1. The subject of agricultural education in country schools was one of those to which the Famine Commissioners, in their Report of 1880, advised that the attention of agricultural departments should be directed. In the opening Resolution of 1881 the Government of India pointed out the necessity of securing the co-operation of the native community in working out any programme of agricultural improvement, and in correspondence which ensued with Her Majesty's Secretary of State on the general policy which a practical interest in agricultural progress and reform.

2 These views were confirmed by the agricultural conference of 1888, which urged that the measure most immediately demanded was that of educating teachers competent to give instructions of the required kind, and in the same year the Government of India, dealing with the proceedings of the 1888 conference and with the report of the Finance Commission on the expenditure of the new department, issued a resolution in which a clear explanation of the No 345-55 C. I, dated general policy advocated was put forward. 23th March 1890

It would be the duty of every Government, it was urged, to ascertain by careful and continuous experiment and enquiry what improvements were possible, and during the long period of years which these investigations would occupy, to give 'classes' 'remnants,' 'and until the ag- was to be avoided. A resolution issued in the same year in the Home Department on educational policy placed a direct obligation on agricultural and educational departments in every province to work out a practical scheme of agricultural education.

3 In one province, Madras, in which an agricultural college had been established for many years, considerable attention had been already given to the educational question, and when in 1890 a committee, appointed by the Government of the presidency to examine the working of the agricultural department and of the college, submitted its report, it was found that the conclusions arrived at pointed in the same direction. 'It is to school and college 'education' wrote the Madras Government 'that the committee 'attach most importance, and more than half of their report is 'devoted to this subject' In view of the fact that the practical experience attained and the serious consideration given to the question for a long period of years in the Madras presidency

entitled the opinion of the committee to great weight, a brief exposition of their views, confirmed as they have been by the conferences recently held both in Madras and in other provinces, deserves a prominent place in this resolution. Their whole report indeed is one which merits the careful perusal and attention of all officers connected with the work of agricultural administration.

4. The main defects in the Madras scheme of agricultural education were found to have been that instruction was specialized in a college of high class, had no connection with the educational curricula of primary and secondary schools, and was confined to students designed for agricultural employment either as officials or on their own estates. The verdict of the committee was this. 'We do not look forward' they wrote, 'to all students of the college

'thorough course of instruction in the agricultural college.' Turning then to the broader question of general education, they continued: 'We are persuaded that no means of increasing the efficiency of the Agricultural Department can be really effective unless the people

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of this country may be enormously increased by improved methods of cultivation, by the introduction of new products, and by the rational treatment and development of stock. Education is the

5. Impressed by the value of these conclusions, founded as they were on practical observation of the inadequate results of an imperfect system, the Government of India commended them to the special notice of the agricultural conference which was to meet the Secretary of State's delegate, Dr. Voelcker, in 1890. That conference fully supported the Madras views. It urged the extension of primary education; the combination of agricultural teaching

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2. These views were confirmed by the agricultural conference of 1888, which urged that the measure most immediately demanded was that of educating teachers competent to give instructions of the required kind, and in the same year the Government of India, dealing with the proceedings of the 1888 conference and with the report of the Finance Commission on the expenditure of the new department, issued a resolution in which a clear explanation of the general policy advocated was put forward. No 245-55 C I, dated 25th March 1890.

It would be the duty of every Government, it was urged, to ascertain by careful and continuous experiment and enquiry what improvements were possible, and during the long period of years which these investigations would occupy, to give serious attention to the education of the agricultural classes. Extravagant expenditure on attempts to introduce improvements until they had been thoroughly tested by experiment and until the agricultural population was prepared to receive them, was to be avoided. A resolution issued in the same year in the Home Department on educational policy placed a direct obligation on agricultural and educational departments in every province to work out a practical scheme of agricultural education.

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'thorough course of instruction in the agricultural college.' Turning then to the broader question of general education, they continued. 'We are persuaded that no means of increasing the efficiency of the Agricultural Department can be really effective unless the people are taught to understand what is defective in their present system of agriculture, where it is capable of improvement, and the best means to that end. We believe that this can only be done, first, by extending their general education; secondly, by teaching them not only to read, write and cypher, but to use their knowledge so that they may, in however humble a manner, become thinkers, observers, experimenters. * * * Unless the intelligence of the cultivator be developed, and developed in such a direction as to lead him to devote a better trained intelligence to his own art, and to apply thought, observation, and experiment to matters which concern his material well being, we believe that progress, if not absolutely impossible, must be so low as to effect little appreciable change in a generation. We assume, as an axiom, that the wealth of this country may be enormously increased by improved methods of cultivation, by the introduction of new products, and by the rational treatment and development of stock. Education is the mightiest lever that can be applied, however great and beneficial the influence on the intelligence of the people of railways, roads, canals, good markets and good ports and outlets for produce may be, these are necessary and helpful to agriculture as educators, but they are not sufficient to ensure the progress possible, and people remain ignorant of the methods.'

Impressed by the value of these conclusions founded as they were on practical observation of the inadequate results of an imperfect system, the Government of India commended them to the special notice of the agricultural conference which was to meet the Secretary of State's delegate, Dr Voelcker, in 1890. The conference fully supported the Madras views. It urged the of primary education, the combination of agricultural

with it; and the employment of students agriculturally trained in all departments of Government service in which an opening could be made for them. In convening the agricultural conference which was to deal with Dr. Vnelcker's Report in 1893, the Government of India again drew the prominent attention of local Governments and Administrations to the subject; and, alluding to the request contained in the Home Department's Resolution of 1888, that the Educational and Agricultural Departments should be required to work out in concert a practical programme, stated that 'it was essential that, with the co-operation of the Educational Departments, measures should be taken which will render the agricultural population capable of assimilating new ideas and of understanding any suggestions made to them, as time goes on, for the improvement of their agricultural methods, and which will qualify them to take that active part in the scheme of agricultural reform without which no effective results can be expected.'

6. These views were confirmed by the conference of 1898 in the Home Department.

It was found that there was a general tendency in the provinces to modify the course of primary education in a practical direction. Part from the the Educational Department's Resolution of 1888, it was found that there was a general tendency in the provinces to modify the course of primary education in a practical direction.

7. Finally, in 1895 the Government of India decided to invite local Governments and Administrations to require the subject to be thoroughly examined in each province by a committee which should be composed of selected officers of the provincial, revenue, and agricultural and educational departments, and which no officer on the imperial staff should be permitted to attend for the purpose of providing facts and statistics from other provinces.

8. Hitherto general principles rather than actual practices had come under consideration. The leading objects of discussion were now to be the positive ascertainment of any defects that might exist in the present scheme of primary education, the extent to which effect had already been given to the principle of including agricultural and practical instruction in the ordinary school curriculum, and the reforms which were still possible in the direction of developing in the younger students the training of agriculturists as the framing of the plan of instruction so as to promote in the pupils taught the power of assimilating any kind of technical instruction; that the mere acquisition of knowledge was to be subordinated to the practical application of it. In bringing the subject of India took the Resolution that the adaptation of the educational system to the training of agriculturists as the framing of the plan of instruction so as to promote in the pupils taught the power of assimilating any kind of technical instruction; that the mere acquisition of knowledge was to be subordinated to the practical application of it. In bringing the subject of India took the Resolution that the adaptation of the educational system to the training of agriculturists as the framing of the plan of instruction so as to promote in the pupils taught the power of assimilating any kind of technical instruction; that the mere acquisition of knowledge was to be subordinated to the practical application of it.

'fit them for their position in life and be not necessarily regarded as 'a portion of instruction leading up to the University,' and they advocated that 'the standards of primary education be revised with 'a view to simplification and to the larger introduction of practical 'subjects such as native methods of arithmetic, accounts and mensuration, the elements of physical and natural science and their 'application to agriculture, health and industrial arts'

12. The general principles thus put forward are in sufficient accord with the policy which as already explained, has met with general acceptance, but are, under the strict letter of the definition adopted by the Commissioners, only applicable to vernacular instruction. It would, in the opinion of the Government of India, be unfortunate if this restriction were to be held to exclude any lower schools, in which education is commenced from the beginning in English, from the material advantages afforded by a system of instruction based on principles which are almost uniformly accepted in all civilized countries, which were advocated by the Education Commission, and which now, after discussions extending over many years, have been strongly urged for adoption as a basis for all educational schemes by the general consensus of provincial authorities. In most of the provinces of India no such exclusion is possible. But the position is not the same in all.

13. The despatches received from Her Majesty's Secretary of State in 1854 and 1859 on the subject of national education indicated that a distinction should be made in the educational courses prescribed for the rich middle and poorer classes respectively. In several provinces the same elementary instruction in the vernacular is provided for the younger pupils of all three classes, and can be moulded into any form which the local Government considers to be best. The trifurcation comes later. In some of the eastern provinces, on the other hand, a separate scheme is provided for each of the three classes from the lowest stage, and in such institutions as may adopt English as the language through which elementary instruction is conveyed the course of study may be determined not so much by the provincial authorities as by the requirements of the course leading to educational diplomas and degrees.

14. The Education Commissioners represented that 'their attention was not called to this important variation in the educational 'scheme of different provinces until discussions on primary education 'had been closed when it was too late to find time for its consideration,' they took some pains however, to marshal all the arguments on both sides but stated that 'in the conflict of views, and 'considering that no opportunity had been given of arriving at a 'definite conclusion they refrained from expressing an opinion'. They explained at the same time that by the system under which the three courses were kept entirely distinct the main object sought was 'to keep down the standard to the requirements of the masses 'and not to raise it by considering the wants of the well-to-do classes 'who are not, properly speaking, the masses'. The Government of India have no desire to enter on the present occasion into any

detailed discussion of the merits of the two systems, but consider it expedient to point out that the reforms now suggested in the primary education of vernacular schools are in no way connected with the special wants of the well-to-do classes, that they are founded on general considerations equally applicable to every class, and that if they conduce to the better development of the intelligence of all children, of whatever condition in life, it would seem to be a question whether this advantage should be withheld from the well-to-do classes. The question is one which seems at least to deserve the consideration of local Governments and Administrations of provinces in which any class of school is excluded from reforms admitted into the general scheme of early education.

15. Turning now to the position of primary education in schools—and in most provinces this means all schools—in which the plan of elementary instruction is controlled, under the direction of the local Government, by the educational departments, it appears to have been ascertained in the course of discussion at the recent conferences that, while in many provinces, and notably in Bombay, material effect had been given to the principles advocated, yet that substantial defects did often exist which it would be desirable to remove. The nature of the imperfections discovered and the character of the remedies suggested will be more easily comprehended if it is first explained what the plan of education ought to be if based on the principles supported at all the conferences.

The first point is that in all schemes of practical education designed to train pupils at an early age in habits of observation, the readers and text books—which should deal, as far as possible, with familiar objects—must be illustrated and explained by the concurrent exhibition of the objects themselves or of pictures and models of them. Thus ‘object lessons’ play an important part in the elementary teaching of every subject, whatever that subject may be, which enters into the curriculum. Even such an abstract ‘subject’ as arithmetic may be elucidated by ‘object lessons,’ while in communicating a ‘knowledge of the commonest natural truths,’ to use Professor Huxley’s phrase, ‘object lessons’ are absolutely essential.

The next point is that all pupils should have the opportunity of gaining a ‘knowledge of common natural truths’, in other words, should be taught elementary science. It is not necessary for this

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receive instructions in every science from the beginning to the end. But that they have no time to go to the end is no reason why they should not be so taught that they may grasp the elementary facts and principles on which the most important sciences are founded, that they may obtain an intelligent knowledge of common natural truths, and that they may have their faculties so developed that in their subsequent career they can easily assimilate instruction in any subject or science which they may elect to take up.

16. Three defects, involving important departures from the canons laid down in the preceding paragraph, were, in one province

or another, found to exist. The *first* was that in the educational curriculum 'object lessons' are sometimes treated as a separate 'subject,' and not only so, but as an 'optional subject,' that is to say, pupils may choose whether or not they will learn 'object lessons' at all, and if they do so choose they study 'object lessons' as something apart from other subjects. It has now been admitted at all the recent conferences that 'object lessons' should be treated as a 'compulsory system' of education and not as an 'optional subject.' This indeed is how they are treated in Bombay and in some other provinces where readers and text books in practically all subjects are illustrated and explained 'by object lessons.'

17 The *second* defect was that many pupils are debarred from attaining a knowledge of common natural truths and principles because the curriculum is so framed as to exclude the teaching of elementary truths and principles in any science or subject, unless that science or subject is followed by the pupil to the very end of the school course. Thus, 'geography' is in some provinces allowed to be an optional subject and the lowest or most elementary 'standard' in geography, i.e., the 'standard' laid down for those boys of the lowest class in a school who take up that subject is 'instruction in the meaning of a map or plan' supplemented by 'making maps of the school room and its compound or by comparing maps of the village and of its surrounding fields with the facts on the ground.' It is obvious that all boys whether they take up geography or not should be taught in this way the meaning of a map or plan, a proper comprehension of which is necessary for all professions, including agriculture, as well as for the ready understanding of all educational works which are illustrated by maps, plans, and diagrams. But under a curriculum which makes 'geography' an optional subject and gives to it exclusive possession of instruction in the meaning of a map or plan, a boy who elects not to learn geography is deprived of the opportunity of learning what a map or plan means.

18 The same subject, geography, may be employed to illustrate the *third* defect, which is that for purposes of elementary education instruction in any one subject taken up is carried too far, so far indeed that time is not left for others equally important. Thus boys who had taken up geography were found to be learning by heart the name and position of every county in England, the advantage which when they first joined the school they had gained over other boys in learning how to read maps and how to draw plans, was thus handicapped later on by the disadvantage involved in the waste of time devoted to acquiring knowledge practically useless to them.

It was admitted at the conferences where the subject was discussed that when once the principles of geography have been learned, and a knowledge of those geographical facts likely to be useful to the pupil through life has been gained, valuable time should not be lost in a wearisome study of details of which a knowledge does nothing to improve the faculty, and is otherwise of little or no positive use, that the time would be far more usefully employed in acquiring a knowledge of 'common natural truths' in other branches of science.

19. It is not the intention of the Government of India to follow province by province the discussions which turned on these questions or to criticise the suggestions made in the direction of reform at each conference. They deem it sufficient to observe that there seems to have been little difference of opinion on the questions raised, that where defects of the kind described had existed the officers representing the education departments supported by the other members of the conferences have agreed to suggest appropriate reforms, and that the local Governments have in every case indicated their willingness to accord favourable consideration to their proposals.

20. On three points only do they consider that definite suggestions or remarks may be useful. The first is this. It appears to have been rightly assumed at the earlier conferences that the term 'elementary science' may be so widely interpreted as to include object lessons illustrating 'natural truths,' the meaning of a map or plan and other simple subjects of the kind, as well as the elements of botany, of zoology and of other so called 'sciences.' Taking this view, they suggested that 'elementary science' thus interpreted should be a 'compulsory' and not an 'optional' subject. This was a step in the right direction. But at the later conferences it was advised that 'elementary science' should not appear in the curriculum at all as a separate subject, but be taught in school readers illustrated by

of the Bombay Presidency and to a certain extent in that of some other provinces, and is commended by the Government of India for favourable consideration elsewhere.

21. The second matter in which attention may be drawn is of importance. In the educational despatch of 1854 Her Majesty's Secretary of State, quoting from the Lieutenant-Governor of the North-Western Provinces, stated that the land record system in 'Indian provinces' offered the stimulus of a direct interest for the

educational course. The conference of 1893 took up this question. 'The ultimate objects,' it was said, 'at which the education of an agriculturist aims are not all of them directly connected with the tillage of the soil. It is of importance to every cultivator that he should be able to understand and interpret the meaning of entries in a cadastral map, that he should have proper acquaintance with

'objects enumerated in the preceding paragraph are often of as much importance to those who, though not actually tillers of the soil, are likely in after-life to hold any interest in land as to those who cultivate it, and that instruction in the direction indicated is as useful

deal exclusively with a particular subject or science. The agricultural conferences of 1890 and 1893 laid much stress on the necessity of simplifying both readers and text-books. The defects pointed out in school books dealing with elementary science and agriculture were that the language employed was often above the comprehension of young boys, that the terms used were too technical, that the vernacular translation of English scientific words was frequently imperfect, that the subject-matter was not seldom badly selected, and that the text-books sometimes aimed at carrying the pupil further than was necessary for any practical purposes.

24 The Government of India is pleased to observe from the proceedings of the recent conferences that a great deal has been done during recent years in almost all provinces to reduce these defects and that further attention is now to be given to the subject. The compilation of good readers and text-books for the young in connection with agriculture and sciences ancillary to agriculture is a task of which the difficulty is not always appreciated. In England the best text books on such subjects have often been written by men of the highest scientific reputation. In some of the continental countries they are compiled and issued under the supervision of the central bureau of the Government. In India, on the other hand, while there have been many useful books compiled for school use, no uniform policy has been adopted in their preparation, and there appears to be in consequence a considerable inequality in the character and value of both readers and text books in various provinces. Taking the case of agriculture, one primer on this subject has been compiled by a civilian, another by an agricultural expert, others have been based on these two books by educational officers, while others again have been independently compiled by non-officials. Evidence was given by a skilled witness at one conference that the current text books on agriculture and other such subjects are quite unsuited for young learners, that they are too abstruse, and that they deal with chemical problems and other matters beyond the comprehension of the pupils.

25 Uniformity in India is impossible. Any attempt at precise uniformity in teaching was deprecated by the Education Commission. The differences of language, of climate and physical condition, of the natural objects used for oral lessons, or as illustrations of school books, of local customs and practices, all these are insurmountable obstacles to uniformity of text in readers and primers required for educational purposes. But it may be doubted whether these variations need stand in the way of a general uniformity of plan and system.

26. It has been said that nothing requires a higher exercise of the intelligence than to serve up knowledge in a form in which it can be easily assimilated and digested by the young, and so far as this is the case, the compilation of school books demands the employment of the best intellects in the country for the work. The question indeed has been raised whether the scheme on which elementary readers and text books relating to agriculture and allied sciences are to be framed should not be worked out and revised from time to time by a competent committee of educational

and other official experts who would, initially, deal only with the frame-work and general design of the educational books, leaving details to be filled in by provincial authorities, so as to suit the circumstances of each locality and who would subsequently offer criticisms on any defects which might present themselves to their notice in the completed books. The subject is, however, one which demands fuller consideration. At present the Government of India are content to record their opinion that readers and text-books dealing with agriculture and allied sciences should not only be brought up to an equally high standard of arrangement, simplicity, and clearness throughout India, but also that they should not fall in these respects below the best standards in Europe, that it would seem difficult to attain this object unless some of the very best men available in the country are allowed to devote for a certain period the whole of their time and attention to the subject, and that the matter is one of such grave importance in connection both with the interests of agriculture and with the sound education of the people as to deserve deliberate investigation.

27 *III — Training Schools* — The Conference of 1893 insisted on the necessity of providing teachers competent to give instruction in the elementary principles of agriculture. The conferences which have now been held go further. They demand that teachers should be trained to teach all elementary sciences on the system of 'readers and object lessons' and in many provinces lay stress on the impossibility of introducing the system unless schoolmasters are specially trained in it themselves. That something has been done in this direction has been admitted, but that, taking India as a whole, progress has not been sufficiently great is clearly proved. One obstacle exists in the fact that the teachers in the lower classes of schools are so poorly paid that they cannot in many parts of India be compelled to go through a course in training schools, another that even in the case of those who do attend the training schools, it is not always easy to provide for them at those schools competent instructors in what is really a difficult branch of a school master's work.

28 The desirability of instructing schoolmasters how to teach by means of object lessons and readers has been acknowledged by local Governments and Administrations, to whom must be left the decision as to what practical measures can be taken to develop training schools in this direction. But apart from this general question there appeared to be, at more than one of the recent provincial conferences, a strong feeling in favour of requiring training school

29 In Madras, where the subject has for some years been under

ment of the farm would be in the hands of the agricultural department and the instruction of training school students in the hands of the educational department, who would utilise the agricultural

farm and the experiments conducted on it for purposes of illustration. The Madras Government, while apprehending that a considerable time will be required to bring the scheme into operation, have accepted these views as sound. In the Central Provinces practical action has been taken in sending annually from each of the western districts four students or schoolmasters after they have passed through the training schools for a six months' course under an Educational officer at the agricultural farm in Nagpur. Strong evidence was given in this province that schoolmasters thus trained were the only efficient teachers of agricultural subjects and of cognate sciences in the schools. The extension of the system was strongly advocated by the revenue officials on the conference.

30. In the North-Western Provinces a few students go through a two years' course at a Government farm, some of whom

ever, as proposed in Madras, and as is the case in the Central Provinces, trained by the educational, but by the agricultural department, and the course is perhaps too long and the numbers too few to have any wide influence on the educational staff.

31. In Bombay, where special attention has been paid in the training schools to the practical instruction of teachers, one of the agricultural teacher recommended schools should be for the instruction of training school students was not raised at Bombay, but the principle has been accepted as regards training school teachers in the suggestion that the College diploma shall include a practical course on the Poona farm.

In Bengal the utilization of the Government farm for the purpose of training schoolmasters was recommended.

Thus, there is a decided movement which has already taken some positive form in the direction of according to schoolmasters a practical training in agricultural subjects.

32. The Government of India recognize the undoubted utility of the policy advocated and accept the preliminary success obtained in the Central Provinces as *prima facie* evidence of its practical results and feasibility. They invite all local Governments and Administrations to bring the question, where this has not already been done, under the serious consideration of their agricultural and educational departments, and to state, in forwarding the agricultural report of the year, what views they have formed on the subject.

33. *IV—Higher agricultural education*—The discussions on these subjects led to important conclusions. The Government of India have not hitherto pressed for the early establishment of high-class agricultural institutions in view of the fact that no sufficient

evidence had yet been produced to show that students trained at them would find any satisfactory opening in life. They held too that high-class educational institutions professing to teach such subjects as agriculture, forestry, veterinary science, etc., should be national rather than provincial; that one or two national colleges would meet the present needs of all India; that the colleges, if
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considered that the agricultural college already existing in the Madras presidency and a second to be attached to the Forest School at Dehra would satisfy the needs of all India.

34. Dr. Voelcker recommended that special attention should be directed to agricultural education in colleges, but added that separate institutions would not be needed if existing colleges of science were expanded by the addition of an agricultural branch. The conference of 1893 did not formulate any specific recommendation, but agreed with the conference of 1890 'that the claims of 'men trained in scientific agriculture to appointments in the revenue 'and cognate departments should be as freely recognized as those of 'men trained in law, arts, and engineering'

35. The question has now been put on a somewhat new footing by the argument urged in the three provinces of Madras, Bombay, and P... culture and... or in an ag... just as well... if not better... it is... This... who have recently carried it into practical effect by a Government order making the diploma in agriculture of the same value as a B.A. degree as a qualification for higher Government service. It was further pointed out at the Madras conference that the proposed measure of passing all training school students through a practical course on a Government farm would require a staff of training school teachers instructed in the more advanced branches of agriculture, and that in recent years ten per cent of the college students be... fore, nee... ployment (3) for...

36. It is evident that if the policy indicated is followed in other provinces there may be justification for a larger number of high-class agricultural colleges than the two advocated by the conference of 1890. The policy has been very strongly pressed in Bombay and is supported by the authorities there on similar... 'We want,' it was written in a... Government, 'as officials in the... xperts, men who have had their 'thoughts directed to agriculture and whose minds have been

'taught to dwell on it; whose reports on the state of the crops, the imminence of famine or the condition of the agricultural population will be animated by personal interest and intelligence of things agricultural, who, when endeavours are made to help the cultivating classes by a State loan, distribution of seed and so forth, or to stimulate them to adopt well tried improvements, will have their zeal quickened by sympathy with, and appreciation of, the measures proposed.' The conferences in Berar and the Central Provinces followed the lead given in Bombay and suggested that students should be sent from those provinces to the Bombay College. The Bengal conference adopting similar views, claimed that the province was justified in having a college of its own, and recommended that the engineering college at Seebpur, near Calcutta, should be expanded for the purpose. The conferences held in the Punjab and the North-Western Provinces endorsed the arguments put forward in Madras and Bombay, but were prepared to advocate the establishment of one college for the two Provinces. In Burma and Assam local conditions did not justify proposals for a high class agricultural institution in either province, though it

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stitutions would meet the ordinary requirements of Berar, the Central Provinces, and the Punjab, and the occasional needs of Burma and Assam. The opinions of local Governments on the question will be separately invited.

37. In every province which possesses or makes use of an agricultural degree, it is urged, be a special provision provided in Madras for elsewhere when the question has been raised of establishing an agricultural degree at the University, in addition to the College diploma and was, when the conference closed, under the consideration of the authorities.

38. A subsidiary question was discussed at the conferences, whether in addition to the college there should be a school at which students should be trained for certain subordinate revenue appointments and for such posts as assistant managers on court wards' estates etc. School classes have already been established at the Government farms in Nagpur and Cawnpore with this object, the Nagpur farm being also utilized by the educational department for the instruction of training school students and schoolmasters. The period of the agricultural course is two years in both places, but the course for schoolmasters is at Nagpur only six months. In Bengal the conference suggested that there should be two courses of different lengths at the same college, the shorter for subordinate officials, the longer for those who aspire to the College diploma. The question is one which requires further consideration and which would be perhaps more satisfactorily worked out by inter communication, with the consent of local

Governments between the educational and agricultural departments of the provinces concerned, and by a review of the results which have been obtained at Nagpur and Cawnpore

39 The local Governments and Administrations in their reviews of the conference proceedings have generally agreed in the policy put forward—and the Government of India are themselves prepared to

record the conclusions which they consider to be justified by the discussions which have been held —

- (1) that agricultural degrees, diplomas, or certificates should be placed on the same footing as corresponding literary or science degrees etc., in qualifying for admission to Government appointments and more particularly those connected with land revenue administration,
- (2) that there should be not more than four institutions giving a high class diploma, *viz*, at Madras, Calcutta, Bombay and some place in the North-Western Provinces, and that these should be utilized by other provinces,
- (3) that the diploma should eventually be compulsory in the case of certain appointments, *e.g.*, agricultural teachers at training schools, assistants to the director of agriculture, etc.,
- (4) that the practical instruction of candidates for certain subordinate appointments at a school class or an experimental farm should be further considered,
- (5) that a special school course leading up to the agricultural diploma, degree or certificate is required,
- (6) that the practice of allowing schoolmasters either before or after appointment to pass through a course of a few months on a Government farm is one which deserves consideration

Agricultural Education.

APPENDIX TO SIXTH RESOLUTION.

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture,—(No. 19—98-1, dated Simla, 20th September 1895.)

Read—

Paragraph 23 of Government of India, Home Department Resolution No. 199, dated 18th June 1894, on the Review of Education in India in 1896.

Proceedings of the fifth meeting of the Agricultural Conference held at Simla in October 1893.

Paragraphs 527 and 529 of Dr. Voelcker's Report on the improvement of Indian Agriculture

Paragraph 17 of Government of India, Home Department, Resolution No. 2, dated 7th September 1894, on the Progress of Education, 1887-88 to 1891-92.

RESOLUTION.

In paragraph 17 of the second Resolution mentioned in the preamble, allusion was made to the fact that the education of the people has now to receive renewed recommendations of the agricultural conference which was convened in October 1893 to consider Dr. Voelcker's Report.

2. The general view taken by the Government of India in the Resolution of 1894 was that greater success is to be expected from making instruction in the primary system of the primary system teaching it as a subject in the primary programme, and that the expansion of the agriculture for themselves the small reforms which are within their means and opportunities, would be more likely to produce substantial results than special instruction in particular agricultural processes. This view is in practical accord with the opinions expressed by the delegates of Local Governments and Administrations at the Conference of 1893. In their second Resolution they recommend

3. The principles which govern the introduction of agricultural instruction into the educational system apply also to all branches of technical instruction. The question, therefore, is not

ernment of India have acknowledged that there is a general tendency to modify the course of primary instruction in the desired direction. In some Provinces material progress has been made. But they are not fully aware how far the principles advocated have been systematically adopted, or to what extent opportunities exist for their wider introduction. Nor have they been informed what action, if any, has been taken on the suggestion in the 25th paragraph of the Resolution of 15th June 1893 that conferences should be held in each Province for the purpose of examining systems in vogue in the various Provinces. The conferences under examination have not, so far as the agricultural classes are concerned, yet assumed the general importance, which they will possess in the future, in view of the fact that as a rule the rural population actually engaged in tillage have not hitherto made any appreciable use of the rural schools otherwise than with the object of training their children for occupations which have no immediate connection with agriculture. But the time must soon come when this position will be changed. Serious discussion of the subject ought not to be longer postponed.

6. The Governor General in Council desires therefore that the suggestion of the Resolution of 15th June 1893 should now be carried out, and that advantage should be taken of the visit of the officer deputed by the Government of India to discuss the proposals of the Agricultural Conference of 1893 to hold in each Province a Conference of such officials as the Local Government may appoint, including, it is suggested, representatives of the Educational and Agricultural Departments, for a formal examination of the Resolutions recorded at the fifth meeting of the Conference of 1893 with the view of submitting definite suggestions and proposals for the consideration of the Local Government or Administration.

7. The Government of India do not wish, until Local Governments and Administrations have had the opportunity of recording their own views, to deal further with the specific proposals of the Conference, nor do they desire to authorize the officer deputed by them to convey any final judgment on the issues raised. The chief duty of that officer will be to place for their information before the Local Governments or their representatives either facts and statistics obtained in other provinces, or the reports of other Provincial Conferences. For the present a sufficient indication has been given of the general views of the Government of India and of the desire of the Governor General in Council that the subject should be earnestly examined in the interests of future agricultural development.

SEVENTH RESOLUTION

PUBLICATION OF AGRICULTURAL INFORMATION.

The despatch of Her Majesty's Secretary of State directing in 1881 the formation of departments of agriculture, stated that one of their main objects was to be 'the rendering available of facts and statistics in order that Government and its officers may always be in possession of an adequate knowledge of the condition of the country, its population, and its resources' This injunction must be held to include the publication in an easily accessible form of all information likely to be useful to the general public.

2. The various agencies established or contemplated by which information, facts, and statistics are or will be collected have already been described They have been brought under three main divisions—(i) Land record establishments, (ii) Scientific departments under imperial direction, and (iii) Provincial departments of agriculture and their experts The duties in respect to collecting and publishing information which devolve in each case upon the provincial and imperial departments, respectively, will now be considered

1—Information derived from land records.

3 Information supplied by the land records and by the establishment which maintain them can be 'rendered available' in three ways

Firstly, by the arrangement of the records themselves in such form that they can be easily searched by district officials and be made to yield readily information of any kind that is required This has been, or now will be, effected in every province in which

The system accepted at the recent nple abstract of the facts and status will at once indicate its progress or cribed in the third Resolution of this series And the whole scheme of land records has now been so arranged in every part of India which possesses land record establishments that information is promptly conveyed to the authorities of injury or distress caused by sudden calamities

Secondly, by the collation and review of the statistics for each district and division for the province and for the whole empire This duty is respectively performed for the province in the annual or periodical reports of district and divisional officers, in the review of them by the land record department, by the higher revenue authorities, and by the local Governments, and for the empire by the compilation and discussion of them in the statistical department of the Government of India, by which department they are published for the information of the general public of the home authorities and of Parliament

Thirdly, by the collection and collation of special facts and statistics under appropriate subject heads. The method which is advised of arranging information under subject heads, with a view to its eventual publication in an intelligible form, will now be described.

4. The system may be most conveniently described as a system of 'ledgering' and is an essential duty of the departments of land records and agriculture. It should be made a part of the annual reports, etc.,

that the system is for convenient reference and may be left to the discretion of the departmental officers. But as the system is one which has been successfully elaborated in the office of the Reporter on Economic Products, that official has been instructed to publish a brief description of it for general information.

5. The Government of India have already indicated in the third Resolution of this series how the land records and the land record establishments can be utilised for supplying facts and statistics in respect to any agricultural practices or conditions which may be the subject of enquiry—such as methods of cultivation, the diseases of crops, etc. Information thus supplied

6. Beyond the information thus specially sought for there are many facts and statistics which are brought to the notice of district officers or otherwise, which are of interest and perhaps eventual use in the abstracts (to which allusion has already been made) of village statistics, (the occurrence of various agricultural defects in particular localities may be brought to light. In one group of villages it may be the prevalence of a noxious weed, in another the continual recurrence of a plant

communicate to the department of land records notes of any remarkable facts bearing on agricultural conditions which may come to their notice through the village abstracts. It would probably suffice that an order should be given by the district officer directing that a copy of any entry in the circle books recording the occurrence and cause of any serious deterioration affecting a group of villages or an agricultural tract should be sent to the office of the Department of Agriculture.

7. It will be presently explained that the system of 'ledgering' advocated will not require that any facts and statistics thus supplied need be immediately utilised by the central department of the province. It will suffice that they should be recorded in their proper place, until the time comes when the subject to which they

relate is brought under special examination. Information thus collected will, when eventually collated and reviewed, be of material use in providing that 'adequate knowledge of the condition of the country' which Her Majesty's Secretary of State called upon agricultural departments to supply.

II.—Information published by scientific departments under imperial control.

8. The second agency by which information is collated and published includes the scientific departments directed by the Government of India. Some of these are independent of provincial aid, their publications being regulated by the heads of the departments in communication with the imperial Government.

9. In every branch of work progress in executive operations is published in annual reports. But other information of more general interest is published in special reports, the character of which will now be briefly described.

In the *Survey* Department the maps and charts that are issued at the head office practically embody the greater part of the geographical information secured by Survey operations.

The *Geological* Department publishes a detailed account of the minerals of India made by its officers. This is published for the public in the Indian Museum at Calcutta. An annual review of the mineral products of India for the information of those interested in mining enterprise and others is published annually at the request of Parliament, and is edited by the reporter on economic products.

The *Meteorological* Department is one on which the obligation to provide full and ample information for the use of officials and of the public was strongly urged by the Famine Commissioners. The measures taken, under the direction of the Government of India, to provide this information are indicated in the fourth section of the report. The department publishes weather reports telegraphically, storm warnings, by weekly and monthly reviews, annual reports on weather published in the official gazettes and by special memoirs on storms, tides and rainfall, the meteorological department has given full effect to the policy which has been pressed upon it.

The *Botanical* Survey of India has recently commenced the issue of a series of 'records,' edited by the director, in which are embodied the results of the investigations of the botanical officers throughout India. These records are published by the director under the title of 'Botanical Records of India,' while the herbaria at the head-quarters of each officer are open to the inspection of the public. The botanical officers are further required to communicate to the reporter on economic products for eventual publication by him any facts of interest which their investigations may bring to light in connection with plants of economic value.

Economic Products have, since the Imperial Department of Revenue and Agriculture was created in 1891, constituted the largest field in which organised measures for collating and publishing information have been taken by the Government of India. In no department of science is information more required by the commercial and general public as well as by officials engaged in administrative work. As already explained in the fourth Resolution of this series in descriptive catalogue under the title of a 'Dictionary of Economic Products' has been prepared and published by Dr. George Watt, the official reporter, its compilation having occupied ten years. But the dictionary was only designed to bring together facts and statistics already recorded in some form in books, reports, and journals, or in the manuscript papers of Government offices. The still more important work of collecting and collating new information has now been commenced, with a view to its ultimate incorporation in a revised edition of the dictionary, as well as to the current publication of so much of it as may be of immediate interest.

10. A scheme has been drawn up under which the current work is divided into three branches —

- (1) The compilation of 'handbooks,' which are practically revised 'dictionary' articles relating to a limited number of economic products, about twenty, of which collections are annually sent to the Imperial Institute. The handbooks are designed for circulation and sale in England and other countries, as well as in India.
- (2) The issue of a series designated 'the Agricultural Ledger' of pamphlets containing any information of interest communicated to the official editor (the reporter on economic products) by any of the scientific or provincial departments. This series covers more ground than is occupied by economic products, including as it does notes on any subject connected with agriculture, but economic products, under which head are comprised all field and garden crops and all forest produce, occupy the largest space in the publication. The agricultural ledger is intended for circulation to all officials interested in the subjects dealt with, as well as for distribution to the public.
- (3) The collection by the reporter of extracts from journals, from settlement reports, and other such sources of information, as well as of notes communicated from time to time by private or official contributors. These are ledged in the reporter's office on a system which brings together all papers referring to the same subject in such manner that the information they contain can be readily utilised and if necessary condensed, whenever the subject may be eventually dealt with, whether in a handbook, a number of the ledger series or, finally, in a dictionary article. At the same time any matter of immediate interest

relate is brought under special examination. Information thus collected will, when eventually collated and reviewed, be of material use in providing that 'adequate knowledge of the condition of the country' which Her Majesty's Secretary of State called upon agricultural departments to supply.

II—Information published by scientific departments under imperial control.

8 The second agency by which information is collated and published includes the scientific departments directed by the Government of India. Some of these are independent of provincial aid, their publications being regulated by the heads of the departments in communication with the imperial Government.

9 In every branch of work progress in executive operations is published in annual reports. But other information of more general interest is published in special reports, the character of which will now be briefly described.

In the *Survey* Department the maps and charts that are issued at the head office practically embody the greater part of the geographical information secured by Survey operations.

The *Geological* Department publishes special memoirs containing a detailed account of the results of any important investigation made by its officers, and exhibits its collections for the inspection of the public in the Indian Museum at Calcutta. An annual review of the mineral products of India for the information of those interested in mining enterprise and others is published annually at the request of Parliament, and is edited by the reporter on economic products.

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to the commercial public is communicated in special circulars to those concerned in anticipation of more formal publication.

11. The heads of all departments, provincial and imperial, have already been invited to bring to the notice of the official editor any passages in reports and publications connected with their work which deserve to be brought to his notice for inclusion in his office ledgers or for communication to the public. The Government of India take the present opportunity to direct continuous attention to this useful practice, which tends to the preservation in an accessible form of much valuable information which would be lost sight of in the pages of reports on current administration or of other blue books which are relegated to the shelves of official record-rooms and seldom again consulted.

12. In the *Veterinary* Department a system of ledgering similar to that employed in the economic product department is adopted. When sufficient information of interest on any subject connected with cattle, horses, animal disease, etc., has been collected by the special officer who, as stated in the fourth Resolution, is charged with this duty, it is communicated in the form of a number of the agricultural ledger series for publication by the official editor.

The *Bacteriological* branch of the department publishes the results of its investigation in a series of special memoirs, which are issued whenever sufficient matter is available for publication. In some cases these would be communicated to the agricultural ledger.

Information collected in the department of *Agricultural Science* is communicated in the manner already explained to the official editor of the agricultural ledger for issue in that series.

In the section of *Agricultural Entomology* memoirs are issued from the Indian Museum by the officer on the staff engaged in investigations in that field. The information collected by him is also made available for publication in the agricultural ledger series.

General information about *Forestry* is conveyed to the public in an annual review published by the Inspector-General of Forests, while any detailed facts and statistics of interest are published in the agricultural ledger series. A useful periodical entitled the '*Indian Forester*,' to which Forest officers are the chief contributors, is utilized by the Department for conveying interesting information to the official and general public.

In the department of general *Statistics* periodical reports, reviewing the statistics received from all provinces and departments, will now be published periodically by the Director-General of the newly-constituted department. These comprise, among others, monthly, quarterly, and annual reports on exports and imports, on inland road, rail and river borne traffic and crop forecasts and outturns. One of the most important publications is an annual return of the agricultural statistics of British India presented to Parliament.

Independently of the new statistical department, the imperial

department of agriculture undertakes the publication, periodically revised, of a *statistical atlas* in which the circumstances and resources of the empire are illustrated by maps, statistical diagrams, and brief descriptive essays contributed by directors of scientific departments or by other selected officials. The second edition of this work has recently been published.

Art and Industries, though not represented by any separate imperial department, have not, in the scheme of publication, been overlooked. An illustrated journal of Indian art, to which all officials and others interested in the subject in India or in Europe are invited to contribute, was, in the year 1888, brought out at the instance and with the aid of the imperial Department of Revenue and Agriculture by a well known London art publisher and is issued monthly. A 'technical art series' containing illustrations of Indian art and architecture is also published by the officer in charge of the Photographic section of the imperial survey office. Both of the above publications are partly designed for educational purposes as well as for preserving a knowledge of the best art of the country. A third series designated 'drawing examples' and also published by the Survey Department, contains a special selection of oriental art drawings for use in schools.

III—Information published by Provincial Departments

13 The third agency upon which the duty devolves of publishing information, facts and statistics on agricultural and scientific subjects otherwise than in connection with land records, comprises the agricultural departments of the provinces and experts under their control.

14 The system of 'agricultural ledgers' adopted by the Government of India was taken from Madras in which presidency for some years the practice of issuing 'agricultural bulletins' had been established. There are many subjects of provincial importance which are too dependent on local conditions and circumstances to be of useful interest to other provinces or to the general public. The maintenance of a provincial as well as of an imperial series of publications is therefore most desirable, and some other provinces have now followed the example of Madras, and the Government of India would be glad to see the practice adopted in every province.

15 Those papers in a provincial series which are of general interest outside the province are, under a scheme for provincial co-operation recently circulated, to be communicated to the editor of the imperial series for wider circulation and in this view the pamphlets of both provincial and imperial publications are to be of the same pattern.

16 The Government of India cannot press too strongly upon local Governments and Administrations the desirability of encouraging the directors of agricultural departments to provide for the free and constant contribution of useful information to the imperial editor. As explained under the previous sections, such information may be of two kinds, either for immediate publication in

the imperial series, or for inclusion in the ledgers of the editorial office. With this object the agricultural department should, subject to the instructions of the Local Government, devise a system under which, as in the imperial departments, all passages in official papers and reports, in which the preservation for future publication may be desirable, should be marked and brought to their notice. To no class of reports do these remarks refer more particularly than to settlement and land administration reports. Much of the interesting information on agricultural subjects contained in them is lost to future generations of officials unless promptly extracted and ledged under appropriate heads. A schedule of the headings which should be adopted for this purpose has been elaborated in consultation with provincial authorities and is now in force throughout India.

17. There is another class of facts and statistics in which the Agricultural Department is essentially interested and which especially demand a careful system of ledgering, viz., the results of experiments on Government farms or of investigations into agricultural practices and conditions. These, which are often of a technical character and of interest only to those actually engaged

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Every provincial department must at least be required to include in the information thus communicated to other departments—

- (1) a statement of the working-plan arranged in consultation with the agricultural chemist for every experimental farm and of the progress made in carrying it out each year, in order that the officials of the agricultural department in each province may be kept punctually informed of the experiments, their objects and results, which are being carried out in all other provinces;
- (2) a statement each year of the agricultural defect or defects which have been made the subject of special enquiry during the past 12 months and a report on the progress and results of the investigation;
- (3) any remarkable facts which may at any time come to the notice of the department, and which are likely to be of interest to the agricultural departments of other provinces.

trated by maps and statistical diagrams, and the measure is recommended by the Government of India for general adoption. Such atlases are of use and interest to the general public as well as to the administration.

19. The main principle which the Government of India conceive it necessary to bear in mind in the development of the scheme for recording facts and statistics is that the record of them in general reports dealing with a variety of subjects is of little or no practical use, unless those which are of interest are at once seized upon and preserved in ledgers under intelligent direction. The principle was accepted by the agricultural conference of 1893, and the Government of India trust that it may now, as far as possible, be carried into effective practice on a well organised system by the departments of land records and agriculture in every province in which action has not yet been taken to this end.

EIGHTH RESOLUTION.

ANNUAL REPORTS

1. One of the subjects which was brought before the agricultural conference of 1893 was the form which should be adopted for the annual reports prepared by provincial agricultural departments. It was, however, decided that the question could best be dealt with where the form of the report, which was to be based upon the information which had been definitely determined by provincial departments has now been finally settled in communication with local authorities and Governments and is embodied in the preceding Resolutions of this series. The annual reports should, in the opinion of the Government of India, follow, as far as possible, the arrangement which has been observed in those Resolutions.

2. The Government of India last dealt with the subject of departmental reports in the 3rd paragraph of their Resolution No. 52, dated 14th September 1887, and do not require that any material departure should be made in future from the instructions which it conveyed and which had for their object the curtailment of annual reports. The paragraph referred to is quoted below for purposes of easy reference—

Paragraph 3 of Resolution No. 52, dated 14th September 1887.

3. *Report of the Department of Land Records and Agriculture*—The annual publication in every Province of the Report of the Department of Land Records and Agriculture in the form prescribed in Circular Resolution No. 54 A, dated the 28th April 1884, is, in the opinion of His Excellency in Council, essential for the purpose of indicating the progress which may be annually made by the Department of Land Records and Agriculture in connection with the measures adopted in the Famine Commissions. The report consists of two main divisions—Land Records and Agriculture—and is designed to show the executive work of the Department, not to comprise discussions on administrative measures, or to contain any description or summary of the economic or agricultural circumstances of the season. The Local Government may, however, require information of this kind to be submitted by the Department to the Chief Revenue authorities of the Province, for utilization in preparing the Land Revenue Administration Report and may prefer that for that purpose it should be included in the land record section of the Departmental Report, rather than be submitted by independent communication. There will be no objection to this course. But there seems to be no reason why statistical statements concerning crops, irrigation, tenures, &c., should find a place in the Report of the Department as well as in the Annual Land Revenue Administration Report, to which latter they

should, in the opinion of His Excellency in Council, be confined. The Agricultural section of the Departmental report should be restricted to an account of the executive operations of the Departmental officers, and to a brief description of, or reference to, any results of special interest which may have been obtained during the preceding twelve months, whether in farms, gardens, Government estates, or otherwise, but should avoid lengthy discussions on agricultural subjects and need not contain any detailed examinations of the working of gardens, farms, or other agricultural institutions which should be dealt with in the Department by orders on the annual reports. In accordance with the above remarks, His Excellency in Council is of opinion that no other review of the Annual Report of the Director of the Department of Land Records and Agriculture than that which may be included in the review by the Local Government of the Land Revenue Administration Report is necessary, and that it will suffice if a copy of the Report, together with any orders which may be passed thereon, is submitted for the information of the Government of India.

3. On 28th April 1884, headings had been prescribed which were based upon the agricultural programme embodied in the Resolution of 1881 dealing with the subjects dealt with. These will hereafter be referred to as the subjects dealt with issued in supersession of the Resolution of 1881.

4. The first Resolution of the new series is prefatory and requires no notice in the annual report. But it will be desirable that the annual report should commence with a prefatory chapter in which will be recorded, among other matters, a brief notice, any changes which may have occurred in the personnel of the Department, and a short description of the tours taken by the Director, and of their general object.

5. The second Resolution deals with the measures taken to improve the land record establishments. The work of the department in most provinces described in a manner consistent with the land revenue administration of the Government of India have no wish to interfere with this procedure, which is doubtless the most convenient to all branches of the administration concerned. But they desire that the annual report of the department should contain a brief notice of the progress made in efficiency and knowledge of survey by the land record establishments, of any new measures which have been taken during the year to improve the standard of the land record officers, of the extent to which promotion has been made to the higher revenue service, and of the

6. The third Resolution deals with the land records.

of the system prescribed for the ...
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 questions
 Resolution V or otherwise.

7. The fourth Resolution deals with the scheme of scientific enquiry carried out by imperial departments. Under this head the report should state to what extent during the ...

... and advice of the imperial officers in any of the fields of scientific enquiry to which the Resolution refers. The progress made in Civil Veterinary work should, in accordance with the instructions of paragraph 13 of the Resolution marginally quoted, be especially described under the various heads detailed in that Resolution.

8. The fifth Resolution refers to positive agricultural experiment and improvement. As stated in the orders of 1884 already quoted in the second paragraph, it is not desirable that the annual report should enter into any lengthy discussions on agricultural subjects or describe the working of the farms. The separate reports on the farms themselves, which are submitted to the local Government, as well as the notes on any interesting experiment or improvement which the Department is required to communicate to the editor of the *Agricultural Ledger* will supply detailed information to all who may require it. The annual report is only intended to indicate the general character of the programme which the ...

... open with a the Depart-
 ... and of the staff by which they are managed; it should indicate the system, if any, which is adopted for carrying experiments into estates under Government or private management, and for obtaining the co-operation of native landowners. It should then give a brief description of, or reference to, any results of special and material interest which ... states during the preceding ... what particular agricultur- ... ct of special investigation ... a report on the results of such ... the *Agricultural Ledger* ... journal in which it is ... necessity of giving any ... account of it in the annual report. Finally, it may include a record of any interesting facts which have been otherwise brought to light during the year in connection with agricultural enquiry and ... cases also a reference to the *Agri* ... the necessity of any-
 thing more.

- V. Scientific and local enquiry under provincial direction.
- VI. Agricultural education
- VII. Publication of agricultural information.
- VIII. Final.

The Government of Madras.
 " " Bombay
 " " Bengal
 " " North West
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 Punjab
 The Chief Commissioner, Central
 Provin-
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 " " " Burma
 " " " Assam
 " " " Ajmere
 " " " Coorg
 The Resident Hyderabad
 ' Inspector General of Forests
 " " Civil Veter

Order—Ordered, that a copy of
 the foregoing Resolutions be for-
 warded to the Local Governments
 and Administrations and officers

information

nary Department
 The Agricultural Chemist to the
 Government of India.
 The Reporter on Economic Pro-
 ducts to the Government of India

Ordered also, that a copy be forwarded to Sir E. Buck, lately Secretary to the Government of India, on special duty.

(True Extract.)

DENZIL IBBETSON,
 Secretary to the Government of India.

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